इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS/IEC 309-1 (1988): Plugs, Socket-Outlets and Couplers for Industrial Purposes, Part 1: General Requirements [ETD 15: Rotating Machinery]

"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

BLANK PAGE

BRUTUM FULMEN

IGNORANTIA JURIS NON EXCUSAT

PROTECTED BY COPYRIGHT

भारतीय मानक

औद्योगिक प्रयोजनों के लिए प्लग, सॉकेट-आउटलेट और कपलर्स

भाग 1 सामान्य अपेक्षाएँ

Indian Standard

PLUGS, SOCKET-OUTLETS AND COUPLERS FOR INDUSTRIAL PURPOSES

PART 1 GENERAL REQUIREMENTS

ICS 29.120.30

© BIS 1996

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

August 1996

Price Group 15

CONTENTS

Clause *Page*

1. Scope 1
2. Definitions 2
3. General requirements 5
4. General notes on tests 5
5. Standard ratings 6
6. Classification 6
7. Marking 7
8. Dimensions 9
9. Protection against electric shock 10
10. Provision for earthing 11
11. Terminals 12
12. Interlocks and retaining devices 17
13. Resistance to ageing of rubber and thermoplastic material 17
14. General construction 18
15. Construction of socket-outlets 18
16. Construction of plugs and connectors 20
17. Construction of appliance inlets 21
18. Degrees of protection 22
19. Insulation resistance and electric strength 23
20. Breaking capacity 25
21. Normal operation 27
22. Temperature rise 28
23. Flexible cables and their connection 29
24. Mechanical strength 32
25. Screws, current-carrying parts and connections 35
26. Creepage distances, clearances and distances through sealing compound 38
27. Resistance to heat, fire and tracking 39
28. Resistance to rusting 41

FIGURES 42

APPENDIX A — Metric and AWG/MCM conductor size equivalents 57

NATIONAL FOREWORD

This Indian Standard (Part 1) is identical to IEC Pub 309-1 (1988) covering General requirements of plugs and socket-outlets and couplers for industrial purposes, issued by International Electrotechnical Commission, was adopted by the Bureau of Indian Standards on the recommendation of the Wiring Accessories Sectional Committee, ET 14 and approval of the Electrotechnical Division Council.

This standard (Part 1) applies to plugs and socket-outlets, cables couplers and appliance couplers, rated current not exceeding 250 A primarily intended for industrial application, either indoor or outdoor.

(Continued on third cover)

Indian Standard

PLUGS. SOCKET-OUTLETS AND COUPLERS FOR INDUSTRIAL PURPOSES

PART 1 GENERAL REQUIREMENTS

INTRODUCTION

This standard is divided into several parts:

Part 1: General requirements, comprising clauses of a general character.

Subsequent parts: Particular requirements dealing with particular types. The clauses of these particular requirements supplement or modify the corresponding clauses in Part 1. Where the text of subsequent parts indicates an "addition" to or a "replacement" of the relevant requirement, test specification or explanation of Part 1, these changes are made to the relevant text of Part 1, which then becomes part of the standard. Where no change is necessary, the words "This clause of Part 1 is applicable" are used.

1. Scope

This standard applies to plugs and socket-outlets, cable couplers and appliance couplers, with a rated operating voltage not exceeding 690 V d.c. or a.c. and 500 Hz a.c. and a rated current not exceeding 250 A, primarily intended for industrial use, either indoors or outdoors.

The list of preferred ratings is not intended to exclude other ratings, requirements for which are under consideration.

This standard applies to plugs and socket-outlets, cable couplers and appliance couplers, hereinafter referred to as accessories, for use when the ambient temperature does not normally exceed 40 °C.

The use of these accessories on building sites and for agricultural, commercial and domestic applications is not precluded.

Socket-outlets or appliance inlets incorporated in or fixed to electrical equipment are within the scope of this standard. This standard also applies to accessories intended to be used in extra-low voltage installations.

This standard does not apply to accessories primarily intended for domestic and similar general purposes.

In locations where special conditions prevail, for example on board ship or where explosions are liable to occur, additional requirements may be necessary.

2. Definitions

Where the terms voltage and current are used, they imply the d.c. or the a.c. r.m.s. values.

The following definitions apply for the purpose of this standard.

The application of accessories is shown in Figure 1.

2.1 *Plug and socket-outlet*

A means enabling the connection at will of a flexible cable to fixed wiring. It consists of two parts:

2.1.1 *Socket-outlet*

The part intended to be installed with the fixed wiring.

A socket-outlet may also be incorporated in the output circuit of an isolating transformer.

2.1.2 *Plug*

The part integral with or intended to be attached to the flexible cable connected to the equipment or to a connector.

2.2 *Cable coupler*

A means enabling the connection at will of two flexible cables. It consists of two parts:

2.2.1 *Connector*

The part integral with or intended to be attached to the flexible cable connected to the supply.

2.2.2 *Plug*

The part integral with or intended to be attached to the flexible cable connected to the equipment or to a connector.

The plug of a cable coupler is identical to the plug of a "plug and socket-outlet". In general, a connector has the same contact arrangement as a socket-outlet.

2.3 *Appliance coupler*

A means enabling the connection at will of a flexible cable to the equipment. It consists of two parts:

2.3.1 *Connector*

The part integral with, or intended to be attached to, the flexible cable connected to the supply.

2.3.2 *Appliance inlet*

The part incorporated in, or fixed to, the equipment or intended to be fixed to it.

In general, the connector of an appliance coupler is identical to the connector of a cable coupler and an appliance inlet has the same contact arrangement as a plug.

2.4 *Rewirable plug or connector*

An accessory so constructed that the flexible cable can be replaced.

2.5 *Non-rewirable plug or connector*

An accessory so constructed that the flexible cable cannot be separated from the accessory without making it permanently useless.

2.6 *Mechanical switching device*

A switching device designed to close and open one or more electric circuits by means of separable contacts.

2.7 *Switched socket-outlet*

A socket-outlet with an associated switching device to disconnect the supply from the socket-outlet contacts.

2.8 *Integral switching device*

A mechanical switching device constructed as a part of an accessory covered by this standard.

2.9 *Interlock*

A device, either electrical or mechanical, which prevents the contacts of a plug from becoming live before it is in proper engagement with a socket-outlet or connector, and which either prevents the plug from being withdrawn while its contacts are live or makes the contacts dead before separation.

2.10 *Retaining device*

A mechanical arrangement which holds a plug or connector in position when it is in proper engagement, and prevents its unintentional withdrawal.

2.11 *Rated current*

The current assigned to the accessory by the manufacturer.

2.12 *Insulation voltage*

The voltage assigned to the accessory by the manufacturer and to which dielectric tests, clearances and creepage distances are referred.

2.13 *Rated operating voltage*

The nominal voltage of the supply for which the accessory is intended to be used.

2.14 *Basic insulation*

The insulation necessary for the proper functioning of the accessory and for basic protection against electric shock.

2.15 *Supplementary insulation (protective insulation)*

An independent insulation provided in addition to the basic insulation, in order to ensure protection against electric shock in the event of a failure of the basic insulation.

2.16 *Double insulation*

Insulation comprising both basic insulation and supplementary insulation.

2.17 *Reinforced insulation*

An improved basic insulation with such mechanical and electrical qualities that it provides the same degree of protection against electric shock as double insulation.

2.18 *Terminal*

A conductive part provided for the connection of a conductor to an accessory.

2.18.1 *Pillar terminal*

A terminal in which the conductor is inserted into a hole or cavity, where it is clamped under the shank of the screw or screws. The clamping pressure may be applied directly by the shank of the screw or through an intermediate clamping member to which pressure is applied by the shank of the screw (see Figure 14a).

2.18.2 *Screw terminal*

A terminal in which the conductor is clamped under the head of the screw. The clamping pressure may be applied directly by the head of the screw or through an intermediate part, such as a washer, clamping plate or anti-spread device (see Figures 14b and 14c).

2.18.3 *Stud terminal*

A terminal in which the conductor is clamped under a nut. The clamping pressure may be applied directly by a suitably shaped nut or through an intermediate part, such as a washer, clamping plate or anti-spread device (see Figure 14d).

2.18.4 *Saddle terminal*

A terminal in which the conductor is clamped under a saddle by means of two or more screws or nuts (see Figure 14e).

2.18.5 *Lug terminal*

A screw terminal or a stud terminal, designed for clamping a cable lug or bar by means of a screw or nut (see Figure 14f).

2.18.6 *Mantle terminal*

A terminal in which the conductor is clamped against the base of a slot in a threaded stud by means of a nut. The conductor is clamped against the base of the slot by a suitably shaped washer under the nut, by a central peg if the nut is a cap nut, or by equally effective means for transmitting the pressure from the nut to the conductor within the slot (see Figure 14g).

2.19 *Clamping unit*

The part of a terminal necessary for the clamping and the electrical connection of the conductor.

2.20 *Type test*

A test of one or more devices made to a certain design to show that the design meets certain specifications.

3. General requirements

Accessories shall be so designed and constructed that in normal use their performance is reliable and without danger to the user or surroundings.

In general, compliance is checked by carrying out all the tests specified.

4. General notes on tests

4.1 *Tests according to this standard are type tests. If a part of an accessory has previously passed tests for a given degree of severity, the relevant type tests shall not be repeated if the severity is not greater.*

4.2 *Unless otherwise specified, the samples are tested as delivered and under normal conditions of use, at an ambient temperature of 20 ± 5 °C; the tests are made at rated frequency.*

4.3 *Unless otherwise specified, the tests are carried out in the order of the clauses of this standard.*

4.4 *Three samples are subjected to all the tests. If, however, the tests of Clauses 20, 21 and 22 have to be made with both d.c. and a.c., the test with a.c. is made on three additional samples.*

4.5 *Accessories are deemed to comply with this standard if no sample fails in the complete series of appropriate tests. If one sample fails in a test, that test and those preceding which may have influenced the test result are repeated on another set of three samples, all of which shall then pass the repeated tests.*

In general, it will only be necessary to repeat the test which caused the failure, unless the sample fails in one of the tests of Clauses 21 and 22, in which case the tests are repeated from that of Clause 20 onwards.

The applicant may submit, together with the first set of samples, the additional set which may be wanted should one sample fail. The testing station will then, without further request, test the additional samples and will reject only if a further failure occurs. If the additional set of samples is not submitted at the same time, the failure of one sample will entail a rejection.

4.6 *When the tests are carried out with conductors, the latter shall be copper and comply with IEC Publications 227, 228 and 245-4.*

5. Standard ratings

5.1 Preferred rated operating voltage ranges and voltages are:

20 V to 25 V	380 V to 415 V
40 V to 50 V	440 V to 460 V
100 V to 130 V	480 V to 500 V
200 V to 250 V	600 V to 690 V
277 V	

5.2 Preferred rated currents are given in the following table:

TABLE I

Series I A	Series II A
16	20
32	30
63	60
125	100
250	200

6. Classification

6.1 Accessories are classified:

6.1.1 according to purpose: plugs, socket-outlets, connectors, appliance inlets;

6.1.2 according to degrees of protection: either in accordance with IEC Publication 529, or according to degrees of protection against moisture:

- ordinary accessories;
- splashproof accessories;
- watertight accessories.

For new designs, degrees of protection according to Publication 529 shall be used.

IPX0/ordinary accessories have no special protection against moisture, and they need not have lids.

In some countries, IPX0/ordinary accessories are not allowed.

6.1.3. according to earthing facilities:

- accessories without earthing contact;
- accessories with earthing contact;

6.1.4 according to the method of connecting the cable:

- rewirable plugs and connectors;
- non-rewirable plugs and connectors;

6.1.5 according to interlocking facilities:

- accessories without interlock, with or without integral switching device;
- accessories with mechanical interlock;
- accessories with electrical interlock.

7. **Marking**

7.1 Accessories shall be marked with:

- rated current(s) in amperes;
- rated operating voltage(s) or range(s) in volts;
- symbol for nature of supply, if the accessory is not intended for both a.c. and d.c., or is intended for a.c. with frequencies other than 50 Hz or 60 Hz, or if the rating is different for a.c. and d.c.;
- rated frequency if exceeding 60 Hz;
- either the name, trade mark or identification mark of the manufacturer or of the responsible vendor;
- type reference, which may be a catalogue number;
- symbol for degree of protection as applicable;
- symbol indicating the position of the earthing contact or the means used for interchangeability, if any.

Optionally, the insulation voltage may be marked.

Compliance is checked by inspection.

7.2 When symbols are used, they shall be as follows:

A	amperes
V	volts
Hz	hertz
~	alternating current
⎓	direct current
⊜ or ⏚	earth
IPX0 or no symbol	ordinary construction
IPX4 or △ (one drop in a triangle)	splashproof construction
IPX7 or △ (two drops)	watertight construction
IPXX (relevant figures)	other constructions

For the marking of rated current(s) and rated operating voltage(s) or range(s), figures may be used alone.

The figure for d.c. rated operating voltage, if any, shall then be placed before the figure for the a.c. rated operating voltage, and separated from it by a line or a dash.

Compliance is checked by inspection.

7.3 For socket-outlets and appliance inlets, the marking for rated current, nature of supply, if necessary, and either the name, trade mark or identification mark of the manufacturer or the responsible vendor shall be on the main part, on the outside of the enclosure, or on the lid, if any, if the latter cannot be removed without the aid of a tool.

Except for flush-type socket-outlets and appliance inlets, these markings shall be easily discernible when the accessory is mounted and wired as in normal use, if necessary after removal from the enclosure. The marking, if any, for the insulation voltage shall be on the main part; it shall not be visible when the accessory is mounted and wired as in normal use.

The marking for rated operating voltage, type reference, the symbol for degree of protection, if required, and the symbol indicating the position of the earthing contact or the means used for interchangeability, if any, shall be on a place which is visible after installation of the accessory, on the outside of enclosure or on the lid, if any, if the latter cannot be removed without the aid of a tool.

With the exception of the type reference, these markings shall be easily discernible when the accessory is mounted and wired as in normal use.

Compliance is checked by inspection.

The term "main part" of a socket-outlet or an appliance inlet means the part carrying the contacts.

The type reference may be marked on the main part.

7.4 For plugs and connectors, the marking specified in Sub-clause 7.1, with the exception of the marking for insulation voltage, if any, shall be easily discernible when the accessory is wired ready for use.

The marking for insulation voltage, if any, shall be on the main part; it shall not be visible when the accessory is mounted and wired as in normal use.

The term "ready for use" does not imply that the plug or connector is in engagement with its complementary accessory.

The term "main part" of a plug or a connector means the part carrying the contacts.

Compliance is checked by inspection.

7.5 For rewirable accessories, the contacts shall be indicated by the symbols:

- for three-phase, the symbols L1, L2, L3, or 1, 2, 3 for the phases, N for neutral, if any, and the symbol ⏚⃝ or ⏚ for earth;

- for two-pole, which may be used for both a.c. and d.c., one symbol for one of the live poles and the symbol (⏚) or ⏚ for earth, if any;

- for a period of time the marking R1, S2, T3 may be used instead of L1, L2, L3.

These symbols shall be placed close to the relevant terminals; they shall not be placed on screws, removable washers or other removable parts.

The terminals for pilot conductors are not required to be indicated.

The figures used with the letters may be written as an index. It is recommended that where practicable the symbol (⏚) should be used.

Compliance is checked by inspection.

7.6 Marking shall be indelible and easily legible.

Compliance is checked by inspection and by the following test:

After the humidity treatment of Clause 18, the marking is rubbed vigorously by hand for 15 s with a piece of cloth soaked in water and again for 15 s with a piece of cloth soaked with petroleum spirit.

Special attention is paid to the marking of the name, trade mark or identification mark of the manufacturer or the responsible vendor and to that of the nature of supply, if any.

A special test for checking the indelibility of these markings is under consideration.

7.7 **If, in addition to the marking prescribed, the rated operating voltage is indicated by means of a colour, the colour code shall be as shown in Table II. An indicating colour, if different from that of the enclosure, shall be used only if it can be easily distinguished.**

TABLE II

Rated operating voltage V	Colour[1] [2]
20 to 25	Violet
40 to 50	White
100 to 130	Yellow
200 to 250	Blue
380 to 480	Red
500 to 690	Black

[1] For frequencies over 60 Hz up to and including 500 Hz, the colour green may be used, if necessary, in combination with the colour for the rated operating voltage.

[2] In countries where accessories of Series II current ratings are used, the colour orange is reserved for 125/250 V a.c. and the colour grey is reserved for 277 V a.c. accessories.

8. **Dimensions**

8.1 **Accessories shall comply with the appropriate standard sheets, if any.**

8.2 It shall not be possible to engage plugs or connectors with socket-outlets or appliance inlets having different ratings, or having different contact combinations.

In addition, the design shall be such that improper connections shall not be possible between:

- the earth and/or pilot plug-contact and a live socket-contact, or a live plug-contact and the earth and/or pilot socket-contact;
- the phase plug-contacts and the neutral socket-contact, if any;
- a neutral plug-contact and a phase socket-contact.

Compliance is checked by inspection.

8.3 It shall not be possible to make single-pole connections between plugs and socket-outlets or connectors, or between appliance inlets and connectors or socket-outlets.

Plugs and appliance inlets shall not allow improper connections with socket-outlets complying with IEC Publication 83 or with connectors complying with IEC Publication 320.

Socket-outlets and connectors shall not allow improper connections with plugs complying with IEC Publication 83 or with appliance inlets complying with IEC Publication 320.

Improper connections include single-pole connections and other connections which do not comply with the requirements for protection against electric shock.

Compliance is checked by inspection.

9. Protection against electric shock

9.1 Accessories shall be so designed that live parts of socket-outlets and connectors, when they are wired as in normal use, and live parts of plugs and appliance inlets, when they are in partial or complete engagement with the complementary accessories, are not accessible.

In addition, it shall not be possible to make contact between a contact of a plug or appliance inlet and a contact of a socket-outlet or connector while any contact is accessible.

Compliance is checked by inspection and, if necessary, by a test on the sample wired as in normal use.

The standard test finger shown in Figure 2 is applied in every possible position, an electrical indicator, with a voltage not less than 40 V, being used to show contact with the relevant part.

Neutral contacts and pilot contacts of socket-outlets and connectors are deemed to be live parts.

9.2 Accessories with earthing contact shall be so designed that:

- when inserting the plug or connector, the earth connection is made before the phase connections and neutral, if any, are made;

- when withdrawing the plug or connector, the phase connections and neutral, if any, are broken before the earth connection is broken.

9.3 It shall not be possible to inadvertently assemble the part carrying plug contacts into the enclosure of a socket-outlet or connector.

Compliance is checked by manual test.

10. Provision for earthing

10.1 Accessories with earthing contact shall be provided with an earthing terminal. Metal-clad fixed accessories with an internal earthing terminal can, in addition, be provided with an external earthing terminal, which, except for flush type socket-outlets, shall be visible from the outside.

Earthing contacts shall be directly and reliably connected to the earthing terminals, except that the earthing terminal of socket-outlets incorporated in the output circuit of an isolating transformer shall not be connected.

Compliance is checked by inspection.

10.2 Accessible metal parts of accessories with earthing contact, which may become live in the event of an insulation fault, shall be reliably connected to the internal earthing terminal(s) by construction.

For the purpose of this requirement, screws for fixing bases, covers and the like are not deemed to be accessible parts which may become live in the event of an insulation fault.

If accessible metal parts are screened from live parts by metal parts which are connected to an earthing terminal or earthing contact, or if they are separated from live parts by double insulation or reinforced insulation, they are not, for the purpose of this requirement, regarded as likely to become live in the event of an insulation fault.

Compliance is checked by inspection and by the following test:

A current of 25 A derived from an a.c. source having a no-load voltage not exceeding 12 V is passed between the earthing terminal and each of the accessible metal parts in turn.

The voltage drop between the earthing terminal and the accessible metal part is measured, and the resistance calculated from the current and this voltage drop.

In no case shall the resistance exceed 0.05 Ω.

Care should be taken that the contact resistance between the tip of the measuring probe and the metal part under test does not influence the test results.

10.3 Earthing contacts shall be capable of carrying a current equal to that specified for the phase contacts without overheating.

Compliance is checked by the test of Clause 22.

10.4 Earthing contacts shall be so shrouded or guarded that they are protected against mechanical damage.

Compliance is checked by inspection.

This requirement precludes the use of side earthing contacts.

11. Terminals

11.1 Rewirable accessories shall be provided with terminals in which connection is made by means of screws, nuts or equally effective devices.

Compliance is checked by inspection.

Requirements for screwless terminals are under consideration.

11.2 Parts of terminals, other than screws, nuts, washers, stirrups, clamping plates and the like, shall be either of:

- copper;
- an alloy containing at least 58% copper for parts that are worked cold or at least 50% copper for other parts;
- or other metal not less resistant to corrosion than copper and having mechanical properties no less suitable.

Steel screws shall be adequately protected against corrosion.

Compliance is checked by inspection and by chemical analysis.

A relaxation of the requirement for parts of terminals is under consideration.

11.3 If the body of an earthing terminal is not part of the metal frame or housing of the accessory, the body shall be of material as prescribed in Sub-clause 11.2 for parts for terminals. If the body is part of the metal frame or housing, the clamping screw or nut shall be of such material.

If the body of the earthing terminal is part of a frame or housing of aluminium or aluminium alloy, precautions shall be taken to avoid the risk of corrosion resulting from contact between copper and aluminium or its alloys.

The requirement regarding the avoidance of the risk of corrosion does not preclude the use of adequately coated metal screws or nuts.

More detailed requirements are under consideration.

Compliance is checked by inspection and by chemical analysis.

A test for determining the resistance to corrosion is under consideration.

11.4 Terminals shall allow the connection of conductors having nominal cross-sectional areas as shown in Table III.

For terminals other than lug terminals, compliance is checked by the following test and by the tests of Sub-clauses 11.7, 11.8 and 11.9.

Gauges as specified in Figure 13, having a measuring section for testing the insertibility of the maximum specified cross-sectional area of Table III shall be able to penetrate into the terminal aperture under their own weight to the designated depth of the terminal.

For pillar terminals in which the end of a conductor is not visible, the hole to accommodate the conductor shall have a depth such that the distance between the bottom of the hole and the last screw will be equal to at least half the diameter of the screw, and in any case not less than 1.5 mm.

Compliance is checked by inspection.

TABLE III

Size of connectable conductors

Rating of the accessory			Internal connection [1]				External earthing connection if any	
Voltage V	Current A		Flexible cables for plugs and connectors Solid or stranded cables for appliance inlets [2]		Solid or stranded cables for socket-outlets [2]			
	Series I	Series II	mm²	AWG/MCM [3]	mm²	AWG/MCM [3]	mm²	AWG/MCM [3]
Not exceeding 50	16	20	4 to 10	12 to 8	4 to 10	12 to 8		
	32	30	4 to 10	12 to 8	4 to 10	12 to 8		
Exceeding 50	16	20	1 to 2.5	16 to 12	1.5 to 4	16 to 12	6	10
	32	30	2.5 to 6	14 to 10	2.5 to 10	14 to 8	10	8
	63	60	6 to 16	10 to 6	6 to 25	10 to 4	25	4
	125	100	16 to 50	6 to 2	25 to 70	4 to 0	25	4
	250	200	70 to 150	00 to 0000	70 to 185 [4]	00 to 250	25	4

[1] Terminals for pilot conductors, if any, shall allow the connection of conductors having the same nominal cross-sectional areas as the internal terminals of 16 A accessories having rated operating voltages exceeding 50 V.

[2] Classification of conductors: according to IEC Publication 228, Clause 2, solid (Class 1); stranded (Class 2); flexible (Class 5).

[3] The nominal cross-sectional areas of conductors are given in square millimeters (mm²). AWG/MCM values are considered as equivalent to mm² for the purpose of this standard.

AWG: American Wire Gauge is a system of identifying wires in which the diameters are found in geometric progression between size 36 and size 0000.

MCM: Mille Circular Mils denotes circle surface unit. 1 MCM = 0.5067 mm².

[4] 150 mm² for 200 A Series II devices.

For terminals complying with Figure 14f, the lug shall accept conductors having nominal cross-sectional areas within the appropriate range specified in the Table III.

Terminals that cannot be checked by the gauges specified in Figure 13 are tested by suitably shaped gauges having the same cross-section as those given in Table III.

11.5 Terminals shall have appropriate mechanical strength.

Screws and nuts for clamping shall have an ISO thread or a thread comparable in pitch and mechanical strength.

Provisionally, SI, BA and UN threads are considered as being comparable in pitch and mechanical strength.

Compliance is checked by inspection, measurement and the test of Sub-clause 25.1. In addition to the requirements of Sub-clause 25.1, the terminals shall not have undergone changes after the test that adversely affect their future use.

11.6 Terminals shall be properly fixed to the accessory and shall not work loose when the clamping screws or nuts are tightened or loosened.

Screws and nuts for clamping the conductors shall not serve to fix any other component.

The clamping means for the conductor may be used to stop rotation or displacement of the plug or socket contacts.

Compliance is checked by inspection and, if necessary, by the test of Sub-clause 25.1.

These requirements do not preclude terminals that are floating or terminals so designed that rotation or displacement of the terminal is prevented by the clamping screw or nut, provided that their movement is appropriately limited and does not impair the correct operation of the accessory.

Terminals may be prevented from working loose by fixing with two screws, by fixing with one screw in a recess such that there is no appreciable play or by other suitable means.

Covering with sealing compound without other means of locking is not deemed to be sufficient. Self-hardening resins may, however, be used to lock terminals which are not subject to torsion in normal use.

11.7 **Terminals shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without damage to the conductor.**

Compliance is checked by inspection and the type tests of the terminals of Sub-clauses 11.8 and 11.9, applied to three separate terminals.

11.8 First test

Verification is made successively with conductors of the largest and smallest cross-sectional areas specified in Table III, using rigid conductors for terminals of socket-outlets or appliance inlets and flexible conductors for terminals of plugs or connectors.

The conductors shall be connected to the clamping unit, and the clamping screws or nuts tightened to two-thirds of the torque indicated in Table XIV. Each conductor is subjected to a pull according to the value in Table IV-I, exerted in the opposite direction to that in which the conductor was inserted. The pull is applied without jerks for 1 min. The maximum length of the test conductor shall be 1 m.

During the test the conductor shall not slip out of the terminal nor shall it break at, or in, the clamping unit.

TABLE IV-I

National cross-sectional area mm²	Pulling force N
1	30
1.5	40
2.5	50
4	50
6	60
10	80
16	90
25	100
50	140
70	160
150	220
185	240

11.9 Second test

This test is carried out first with the smallest cross-sectional area and then with the largest cross-sectional area of the relevant values in Table III for rigid and flexible conductors. The clamping screws or nuts are tightened with the torque according to Table XIV. The terminal is fastened to a conductor whose length is at least 75 mm longer than the height specified in Table IV-II, and is secured rigidly in a vertical position simulating actual service conditions. The free end of the cable is passed through a bushing of the size specified in Table IV-II. The bushing is attached to an arm, driven by a motor at a rate of approximately 9 r.p.m. and in such a manner that the centre of the bushing is made to describe a circle in a horizontal plane (see Figure 15).

The circle shall have a diameter of 75 ± 2 mm, and its centre shall be vertically below the centre of the conductor opening in the terminal. The bushing is lubricated to prevent binding, twisting or rotation of the insulated cable. A weight as specified in Table IV-II is suspended from the free end of the conductor. The duration of the test is 1 min.

During the test the conductor shall not pull out of the clamping unit.

Breaking of the conductor or of any strand of a stranded conductor is determined by examining the entire terminal while the conductor is still connected after the test. The conductor or strand of a stranded conductor shall not be visibly detached.

TABLE IV-II

Cross-sectional area of a rigid conductor mm²	Diameter of bushing mm	Height mm	Weight N
1	6.5	240	15
1.5	6.5	260	20
2.5	9.5	280	25
4	9.5	280	25
6	9.5	280	30
10	9.5	280	40
16	13	300	50
25	13	300	50
50	16	350	80
70	20	370	80
150	22	400	110
185	26	430	120

Revision of this test is under consideration.

11.10 Lug terminals shall be used only for accessories having a rated current of at least 63 A; if such terminals are provided, they shall be fitted with spring washers or equally effective locking means.

Compliance is checked by inspection.

11.11 Each terminal shall be located in proximity to its corresponding terminal or terminals of different polarity, and to the internal earthing terminal, if any, unless there is a sound technical reason to the contrary.

Compliance is checked by inspection.

11.12 Clamping screws or nuts of earthing terminals shall be adequately locked against accidental loosening, and it shall not be possible to loosen them without the aid of a tool.

Unless two screws in pillar type terminals are used, a test is required to prove the locking capabilities.

A test is under consideration.

Compliance is checked by inspection and by manual test.

11.13 Terminals shall be so located or shielded that:

- screws becoming loose from the terminals cannot establish any electrical connection between live parts and metal parts connected to the earthing terminal;
- conductors becoming detached from live terminals cannot touch metal parts connected to the earthing terminal;
- conductors becoming detached from the earthing terminal cannot touch live parts.

This requirement applies also to terminals for pilot conductors.

Compliance is checked by inspection and by manual test.

11.14 When the conductors have been correctly fitted, there shall be no risk of accidental contact between live parts of different polarity or between such parts and accessible metal parts, and, should a wire of a stranded conductor escape from a terminal, there shall be no risk that wires emerge from the enclosure.

The requirement with regard to the risk of accidental contact between live parts and accessible metal parts does not apply to accessories having rated voltages not exceeding 50 V.

Compliance is checked by inspection and, where the risk of accidental contact between live parts and other metal parts is concerned, by the following test.

An 8 mm length of insulation is removed from the end of a flexible conductor having a cross-sectional area in the middle of the range specified in Sub-clause 11.4. One wire of the stranded conductor is left free and the other wires are fully inserted into and clamped in the terminal. The free wire is bent, without tearing the insulation back, in every possible direction, but without making sharp bends round barriers.

The free wire of a conductor connected to a live terminal shall neither touch any metal part which is not a live part nor emerge from the enclosure, and that of a conductor connected to the earthing terminal shall not touch any live part.

If necessary, the test is repeated with the free wire in another position.

12. Interlocks

12.1 An interlock shall be incorporated in socket-outlets and connectors not complying with the appropriate tests for breaking capacity and normal operation.

Interlocks shall be linked with the operation of a switching device so that the plug can neither be withdrawn from the socket-outlet or connector while the contacts are alive, nor be inserted while the switching device is in the "ON" position.

Socket-outlets and connectors shall be so designed that, after engagement with any complementary accessory, the interlock operates correctly.

The operation of an interlock shall not be impaired by normal wear of the portion of the plug used for interlocking.

The mechanical switching device for a mechanical interlock may be incorporated in the socket-outlet or connector.

Compliance is checked by inspection after the tests of Clause 21.

12.2 Mechanical switching devices for interlocked a.c. switched socket-outlets shall be in a utilization category of at least AC 22 according to IEC Publication 408.

Mechanical switching devices for interlocked d.c. switched socket-outlets or connectors shall be of category of duty according to the application.

Accessories having an integral switching device and operated by the plug need not comply with requirements of IEC Publication 408 but shall be in accordance with Clauses 20 and 21 of this standard.

Compliance is checked by inspection, by measurement and by tests.

13. Resistance to ageing of rubber and thermoplastic material

Accessories with enclosures of rubber or thermoplastic material, and parts of elastomeric such as sealing rings and gaskets, shall be sufficiently resistant to ageing.

Compliance is checked by an accelerated ageing test made in an atmosphere having the composition and pressure of the ambient air.

The samples are suspended freely in a heating cabinet, ventilated by natural circulation. The temperature in the cabinet and the duration of the ageing test are:

70 ± 2 °C and 10 days (240 h), for rubber;

80 ± 2 °C and 7 days (168 h), for thermoplastic material.

After the samples have been allowed to attain approximately room temperature, they are examined and shall show no crack visible to the naked eye, nor shall the material have become sticky or greasy.

After the test, the samples shall show no damage which would lead to non-compliance with this standard.

If there is a doubt as to whether the material has become sticky, the sample is placed on one of the pans of a balance and the other pan is loaded with a mass equal to the mass of the sample plus 500 g. Equilibrium is then restored by pressing the sample with the forefinger, wrapped in a dry piece of coarse woven cloth.

No trace of the cloth shall remain on the sample and the material of the sample shall not stick to the cloth.

The use of an electrically heated cabinet is recommended.

Natural circulation may be provided by holes in the walls of the cabinet.

14. General construction

14.1 Accessible surfaces of accessories shall be free from burrs, flashes and similar sharp edges.

Compliance is checked by inspection.

14.2 Screws or other means for fixing the part carrying the socket-outlet contact or the part carrying the plug contact to its mounting surface, in a box or in an enclosure, shall be easily accessible.

These fixings and those which fix the enclosure shall not serve any other purpose except in the case whereby an internal earthing connection is established automatically and in a reliable way by such a fixing.

Compliance is checked by inspection.

14.3 It shall not be possible for the user to alter the position of the earthing contact, or of the neutral contact, if any, in relation to the means of non-interchangeability of the socket-outlet or connector, or in relation to the means of non-interchangeability of the plug or appliance inlet.

Compliance is checked by manual test to ensure that only one mounting position is possible.

14.4 Socket-outlets and connectors when mounted as in normal use and without a plug in position shall ensure the degree of protection specified on its marking.

In addition, when a plug or appliance inlet is fully engaged with the socket-outlet or connector, the lower degree of protection of the two accessories shall be ensured.

Compliance is checked by inspection.

15. Construction of socket-outlets

15.1 Contacts shall be so designed as to ensure adequate contact pressure when completely engaged with the corresponding plug.

Compliance is checked by the temperature-rise test of Clause 22.

15.2 The pressure exerted between the socket and plug contacts shall not be so great as to make insertion and withdrawal of the plug difficult. It shall not be possible for the plug to work out of the socket-outlet in normal use.

Compliance is checked by inspection.

15.3 Socket-outlets shall be so constructed as to permit:

- the conductors to be easily introduced into the terminals and secured therein;
- the correct positioning of the conductors, without their insulation coming into contact with live parts of a polarity different from that of the conductor;
- the covers or enclosures to be fixed easily after connection of the conductors.

Compliance is checked by inspection and by an installation test with conductors of the largest cross-sectional area specified in Table III.

15.4 Enclosures and parts of a socket-outlet providing protection against electric shock shall have adequate mechanical strength; they shall be securely fixed in such a way that they will not work loose in normal use. It shall not be possible to remove these parts without the aid of a tool.

Compliance is checked by inspection.

15.5 Cable entries shall allow the introduction of the conduit or the protective covering of the cable so as to afford complete mechanical protection.

Compliance is checked by inspection and by an installation test with conductors of the largest cross-sectional area specified in Table III.

15.6 Insulating linings, barriers and the like shall have adequate mechanical strength and shall be fixed to the metal casing or the body in such a way that either they cannot be removed without being seriously damaged or be so designed that they cannot be replaced in an incorrect position.

Compliance is checked by inspection and by the tests of Sub-clause 18.2 and Clause 24.

The use of self-setting varnish is allowed for fixing insulating linings.

15.7 When a plug is not engaged, socket-outlets shall be totally enclosed when fitted with screwed conduits, or polyvinyl chloride sheathed cables. The means for achieving total enclosure and that for ensuring the marked degree of protection, if any, shall be securely fixed to the socket-outlet. In addition, when a plug is completely engaged, the socket-outlet shall incorporate means for ensuring the marked degree of protection.

Lid springs, if any, shall be of corrosion-resistant material such as bronze, stainless steel or other suitable material adequately protected against corrosion.

Socket-outlets, splashproof or up to and including IPX4 designed for only one mounting position may have provision for opening a drain-hole at least 5 mm in diameter or 20 mm^2 in area with a width of at least 3 mm which is effective when the socket-outlet is in the mounting position.

Compliance is checked by inspection, by measurement and by the tests of Clauses 18, 19 and 21.

The total enclosure and the marked degree of protection may be achieved by means of a cover.

A drain-hole in the back of the enclosure of a socket-outlet, splashproof or up to and including IPX4 intended to be mounted on a vertical wall is deemed to be effective only if the design of the enclosure ensures a clearance of at least 5 mm from the wall, or provides a drainage channel of at least the size specified.

15.8 Socket-outlets having rated operating voltages exceeding 50 V shall be provided with earthing contacts.

Compliance is checked by inspection.

16. Construction of plugs and connectors

16.1 The enclosure of plugs and connectors shall completely enclose the terminals and the ends of the flexible cable.

The construction of rewirable plugs and connectors shall be such that the conductors can be properly connected and the cores kept in place so that there is no risk of contact between them from the point of separation of the cores to the terminals.

Accessories shall be so designed that they can only be reassembled so as to ensure the correct relationship between the components as originally assembled.

Compliance is checked by inspection and, if necessary, by manual test.

16.2 The various parts of a plug or connector shall be reliably fixed to one another in such a way that they will not work loose in normal use. It shall not be possible to dismantle plugs or connectors without the aid of a tool.

Compliance is checked by manual test and by the test of Sub-clause 24.3.

16.3 If an insulating lining is provided, it shall have adequate mechanical strength and shall be secured to the enclosure in such a way that either it cannot be removed without being seriously damaged or it is so designed that it cannot be replaced in an incorrect position.

Compliance is checked by inspection and by the tests of Sub-clauses 18.2 and 24.3.

The use of self-setting varnish is allowed for fixing insulating linings.

16.4 Plug contacts shall be locked against rotation and shall not be removable without dismantling the plug.

Compliance is checked by inspection and by manual test.

Contacts of plugs may be either floating or fixed.

16.5 Contacts of connectors shall be self-adjusting so as to ensure adequate contact pressure.

Contacts other than the earth contact shall be floating.

Earth contacts need not be floating provided that they have the necessary resilience in all directions.

Compliance is checked by inspection and by test.

16.6 The pressure exerted by the contacts of connectors on the plug contacts shall not be so great as to make insertion and withdrawal of the plug difficult. It shall not be possible for the plug to work out of the connector in normal use.

Compliance is checked by inspection.

16.7 Plugs shall incorporate means for ensuring the marked degree of protection against humidity when in complete engagement with the complementary accessory.

It shall not be possible to dismantle this means without the aid of a tool.

Compliance is checked by inspection and by the tests of Clauses 18 and 19.

16.8 Connectors shall be totally enclosed when fitted with a flexible cable as in normal use and when not in engagement with a complementary accessory. In addition, they shall incorporate means for ensuring the marked degree of protection when in complete engagement with the complementary accessory. *

The marked degree of protection against humidity when the complementary accessory is not in position may be achieved by means of a lid or cover.

The means for ensuring the marked degree of protection shall be securely fixed to the connector.

Lid springs shall be of corrosion-resistant material, such as bronze, stainless steel or other suitable materials adequately protected against corrosion.

Compliance is checked by inspection and by the tests of Clauses 18, 19 and 21.

16.9 Plugs and connectors having rated operating voltages exceeding 50 V shall be provided with earthing contacts.

Compliance is checked by inspection.

17. Construction of appliance inlets

17.1 Plug-contacts shall be locked against rotation and shall not be removable without the aid of a tool.

Compliance is checked by inspection and by manual test.

Contacts may be either floating or fixed.

17.2 Appliance inlets shall incorporate means for ensuring the marked degree of protection against humidity when an appropriate connector is completely engaged.

It shall not be possible to dismantle this means without the aid of a tool.

Compliance is checked by inspection and by the tests of Clauses 18 and 19.

17.3 Appliance inlets having rated operating voltage exceeding 50 V shall be provided with earthing contacts.

Compliance is checked by inspection.

18. Degrees of protection

18.1 Accessories shall have the degrees of protection marked on the products.

Compliance is checked by the appropriate tests mentioned in the sub-clauses below.

The tests are made on accessories fitted with the cables or conduits for which they are designed, screwed glands and fixing screws of enclosures and covers being tightened with a torque equal to two-thirds of that applied in the tests of Sub-clause 24.5 or 25.1, as appropriate.

Screwed caps, if any, are tightened as in normal use.

Socket-outlets are mounted on a vertical surface so that the open drain-hole, if any, is in the lowest position and remains open.

Connectors are placed in the most unfavourable position and the drain-hole, if any, remains open.

Socket-outlets and connectors are tested with and also without the complementary accessory in engagement, the means for ensuring the required degree of protection against moisture being positioned as in normal use.

Plugs and appliance inlets are only tested when in engagement with the complementary accessory.

18.2 Accessories marked with IP symbols shall be tested in accordance with Sub-clause 18.1 and IEC Publication 529.

Immediately after the tests, the samples shall withstand the electric strength test specified in Sub-clause 19.3, and inspection shall show that water has not entered the samples to any appreciable extent and has not reached live parts.

18.3 Accessories marked with drop symbols shall be tested in accordance with Sub-clauses 18.1 and 18.4.

18.4 The enclosure of splashproof and watertight accessories shall provide the degree of protection in accordance with the classification of the accessory.

a) *Splashproof accessories are sprayed with water for 10 min by means of the spray apparatus, shown in Figure 3, which comprises a tube formed into a semi-circle. The radius of the circle is 200 mm or a multiple of 200 mm and is as small as is compatible with the size and position of the sample. The tube is perforated so that jets of water are directed towards the centre of the circle, and the water pressure at the inlet to the apparatus is equivalent to a head of about 10 m.*

The tube is caused to oscillate through an angle of 120°, 60° on either side of the vertical, the time for one complete oscillation (120° × 2) being about 4 s.

The sample is mounted at the centre of the semi-circle formed by the tube, so that its lowest part is level with the axis of oscillation. During the test, the sample is turned about its vertical axis or moved transversally.

Immediately afterwards, the sample is subjected for 5 min to splashing in all directions by means of the splash apparatus shown in Figure 4. During this test, the water pressure is so regulated that the water splashes up 15 cm above the bottom of the bowl. The *bowl is placed on a horizontal support 5 cm to 10 cm below the lowest edge of the sample; the bowl is moved around so as to splash the sample from all directions. Care is taken that the sample is not hit by the direct jet.*

b) Watertight accessories are immersed for 24 h in water at a temperature of 20 ± 5 °C, the highest point of the sample being about 5 cm below the water level.

Immediately after the treatment specified under Items a) or b), the samples shall withstand the dielectric strength test specified in Sub-clause 19.3, and inspection shall show that water has not entered the samples to any appreciable extent and has not reached live parts.

18.5 All accessories shall be proof against humid conditions which may occur in normal use.

Compliance is checked by the humidity treatment described in this sub-clause, followed immediately by the measurement of the insulation resistance and by the dielectric strength test, specified in Clause 19. Cable entries, if any, are left open; if knock-outs are provided, one of them is opened.

Covers which can be removed without the aid of a tool are removed and subjected to the humidity treatment with the main part; spring lids are open during this treatment.

The humidity treatment is carried out in a humidity cabinet containing air with a relative humidity maintained between 91% and 95%. The temperature of the air, at all places where samples can be located, is maintained within 1 °C of any convenient value t between 20 °C and 30 °C.

Before being placed in the humidity cabinet, the samples are brought to a temperature between t and $t + 4$ °C.

The samples are kept in the cabinet for:

2 days (48 h) for ordinary accessories,
7 days (168 h) for all other accessories.

In most cases, the samples may be brought to the temperature specified by keeping them at this temperature for at least 4 h before the humidity treatment.

A relative humidity between 91% and 95% can be obtained by placing in the humidity cabinet a saturated solution of sodium sulphate (Na_2SO_4) or potassium nitrate (KNO_3) in water, having a sufficiently large contact surface with the air.

In order to achieve the specified conditions within the cabinet, it is necessary to ensure constant circulation of the air within it and, in general, to use a cabinet which is thermally insulated.

After this treatment, the samples shall show no damage within the meaning of this standard.

19. **Insulation resistance and dielectric strength**

19.1 The insulation resistance and the dielectric strength of accessories shall be adequate.

Compliance is checked by the tests of Sub-clauses 19.2 and 19.3, which are made immediately after the test of Sub-clause 18.5 in the humidity cabinet or in the room in *which the samples were brought to the prescribed temperature, after reassembly of covers which may have been removed.*

Accessories with enclosures of thermoplastic material are subjected to the additional test of Sub-clause 19.4.

For the purpose of these tests, the neutral contact and the pilot contact are each considered as a pole.

19.2 *The insulation resistance is measured with a d.c. voltage of approximately 500 V applied, the measurement being made 1 min after application of the voltage.*

The insulation resistance shall be not less than 5 MΩ.

The term "body" includes all accessible metal parts, metal foil in contact with the outer surface of external parts of insulating material, other than the engagement face of connectors and plugs, fixing screws of bases, enclosures and covers, external assembly screws and earthing terminals, if any.

19.2.1 *For socket-outlets and connectors, the insulation resistance is measured consecutively:*

- *a) between all poles connected together and the body, the measurement being made with and also without a plug in engagement;*
- *b) between each pole in turn and all others, these being connected to the body, with a plug in engagement;*
- *c) between any metal enclosure and metal foil in contact with the inner surface of its insulating lining, if any, a gap of approximately 4 mm being left between the metal foil and the edge of the lining;*
- *d) between any metal part of the cable anchorage of connectors and metal foil wrapped round the flexible cable, or a metal rod of the same diameter as the flexible cable, inserted in its place.*

19.2.2 *For plugs and appliance inlets, the insulation resistance is measured consecutively:*

- *a) between all poles connected together and the body;*
- *b) between each pole in turn and all others, these being connected to the body;*
- *c) between any metal enclosure and metal foil in contact with the inner surface of its insulating lining, if any, a gap of approximately 4 mm being left between the metal foil and the edge of the lining;*
- *d) between any metal part of the cable anchorage of plugs and metal foil wrapped round the flexible cable, or a metal rod of the same diameter as the flexible cable inserted in its place.*

19.3 *A voltage of substantially sine-wave form, having a frequency of 50 Hz/60 Hz and the value shown in Table V is applied for 1 min between the parts indicated in Sub-clause 19.2.*

TABLE V

Insulation voltage of the accessory [1] V	Test voltage V
Up to and including 50	500
over 50 up to and including 415	2 000[2]
over 415 up to and including 500	2 500
over 500	3 000

[1] The insulation voltage is at least equal to the highest rated operating voltage.

[2] This value is increased to 2 500 V for metal enclosures lined with insulating material.

Initially, no more than half the prescribed voltage is applied, then it is raised rapidly to the full value.

No flashover or breakdown shall occur during the test.

Glow discharges without drop in voltage are neglected.

19.4 Immediately after the test of Sub-clause 19.3, it shall be verified that for accessories with enclosures of thermoplastic material the means of providing non-interchangeability have not been impaired.

20. **Breaking capacity**

Accessories without interlock shall have adequate breaking capacity.

Compliance is checked by testing any accessory with a new complementary accessory that complies with the relevant standard.

The test position shall be horizontal or, if not possible, as in normal use.

Any accessory having an integral switching device operated by the plug or appliance inlet shall be mounted as in normal use.

The plug or connector is inserted into and withdrawn from the socket-outlet or appliance inlet at a rate of 7.5 strokes per minute.

The speed of insertion and separation of the plug or connector shall be 0.8 ± 0.1 m/s.

The measurement of speed is made by recording the interval of time between insertion or separation of the main contacts and the insertion or separation of the earthing contact, relative to the distance.

Electrical contacts shall be maintained for no more than 4 s and no less than 2 s.

The two accessories shall be separated at least by 50 mm.

The number of cycles is specified in Table VI.

A stroke is an insertion or a withdrawal of a plug or appliance inlet.

A cycle is composed of two strokes, one for insertion and one for withdrawal.

The samples are tested at 1.1 times the rated operating voltage and 1.25 times the rated current.

Accessories for a.c. only are tested with a.c. in a circuit with $\cos \varphi$ *as defined in Table VI.*

Accessories for d.c. only are tested with a non-inductive load.

Accessories having a rated operating voltage or rated current higher for a.c. than for d.c. are tested with d.c. in a non-inductive circuit, and with a.c. in a circuit such that $\cos \varphi$ *is as in Table VI. A new set of accessories is used for the second test.*

The test is made using the connections shown in Figure 5 except that for accessories having a rated voltage of 380 V–415 V, the metal support is permanently connected to the neutral. In all other cases, for two-pole accessories the selector switch C, connecting the metal support and the accessible metal parts to one of the poles of the supply, is operated after half the number of strokes; for three-pole accessories, the selector switch C is operated after one-third of the number of strokes and again after two-thirds of the number of strokes, so as to connect each pole in turn.

Resistors and inductors are not connected in parallel, except that, if an air-core inductor is used, a resistor taking approximately 1% of the current through the inductor is connected in parallel with it. Iron-core inductors may be used, provided the current has substantially sine-wave form. For the tests on three-pole accessories, three-core inductors are used.

During the test, no sustained arcing shall occur.

After the test, the samples shall show no damage impairing their further use and the entry holes for the plug contacts shall not show any serious damage.

TABLE VI

Breaking capacity

Rated current A			Number of cycles		
Preferred ratings		Other ratings	a.c.		d.c.
Series I	Series II	Range	$\cos \varphi$ ±0.05	on load	on load
16	20	up to 29	0.6	50	50
32	30	from 30 to 59	0.6	50	50
63	60	from 60 to 99	0.6	20	20
125	100	from 100 to 199	0.7	20	20
250	200	from 200 to 250	0.8	10	10

21. Normal operation

Accessories shall withstand, without excessive wear or other harmful effect, the mechanical, electrical and thermal stresses occurring in normal use.

Compliance is checked by testing any accessory with a new complementary accessory that complies with the relevant standard.

This test is carried out by the same means as in Clause 20 used in the manner indicated in that clause.

The test position is as specified in Clause 20.

The test is made using the connections indicated in Clause 20, the selector switch C being operated as prescribed in that clause.

The plug or connector is inserted into or withdrawn from the socket-outlet or appliance inlet at a rate of 7.5 strokes per minute.

Accessories are submitted alternately to cycles with and without current flowing except those rated at 16/20 A which are only tested under load.

The samples are tested at a rated operating voltage and rated current.

After each 500 strokes, the contacts of the plug are wiped with a piece of dry cloth.

Accessories without interlock which have been subjected to the tests of Clause 20 are tested with a number of cycles specified in Table VII. Accessories for a.c. only are tested with a.c. in a circuit with cos φ as specified in Table VII.

Accessories for d.c. only are tested with a non-inductive load.

Accessories having a rated operating voltage or rated current higher for a.c. than for d.c. are tested with both d.c. in a non-inductive circuit, and with a.c. in a circuit such that cos φ is as in Table VII. A new set of accessories is used for the second test.

Accessories with interlock are tested without current flowing, the interlock being locked and unlocked after each complete insertion of the plug.

The number of cycles is the sum of the on and off load of Table VII.

During the test, no sustained arcing shall occur.

After the test, the samples shall show:

- *no wear impairing the further use of the accessory or of its interlock, if any;*
- *no deterioration of enclosures or barriers;*
- *no damage to the entry holes for the plug contacts that might impair proper working;*
- *no loosening of electrical or mechanical connections;*
- *no seepage of sealing compound.*

The samples shall then withstand an electric strength test made in accordance with Sub-clause 19.3, the test voltage, however, being decreased by 500 V for accessories having an insulation voltage exceeding 50 V.

The humidity treatment is not repeated before the electric strength test of this sub-clause.

Lid springs, if any, are tested by completely opening and closing the lid, the number of times the lid is opened being the same as the number of insertions of the plug specified in Table VII.

This test may be combined with the test for the accessories.

TABLE VII

Normal operation

Rated current A			Number of cycles				
Preferred rating		Other rating	a.c.			d.c.	
Series I	Series II	Range	$\cos \varphi$ ± 0.05	on load	off load	on load	off load
16	20	up to 29	0.6	5 000	–	5 000	–
32	30	30 to 59	0.6	1 000	1 000	1 000	1 000
63	60	60 to 99	0.6	1 000	1 000	500	500
125	100	100 to 199	0.7	250	250	250	250
250	200	200 to 250	0.8	125	125	125	125

22. Temperature rise

Accessories shall be so constructed that the temperature rise in normal use is not excessive.

Compliance is checked by testing any accessory with a new complementary accessory that complies with the relevant standards.

The test current is an alternating current of the value shown in Table VIII.

Rewirable accessories are fitted with conductors of a cross-sectional area as specified in Table VIII, the terminal screws or nuts being tightened with a torque equal to two-thirds of that specified in Sub-clause 25.1.

For the purpose of this test, a length of at least 2 m of the cable is connected to the terminals.

Non-rewirable accessories are tested as delivered.

For accessories having three or more poles, the test current during the test shall be passed through the phase contacts. If there is a neutral contact, a separate test shall be carried out passing the test current through the neutral contact and the nearest phase contact.

A further separate test shall be carried out passing the test current through the earthing contact and the nearest phase contact.

A current of 2 A shall be passed through the pilot contact, if any, at the same time as any of these tests.

TABLE VIII

Preferred rated current (A)		Test current (A)	Cross-sectional area(s) of the conductors	
			Plugs Appliance inlets Connectors	Socket-outlets
Series I	Series II		mm^2	mm^2
16	20	22	2.5[1]	4[1]
32	30	42	6[1]	10
63	60	rated current	16	25
125	100	rated current	50	70
250	200	rated current	150	185[2]

[1] For accessories having a rated operating voltage not exceeding 50 V, the values are increased to 10.

[2] 150 mm^2 for 200 A Series II.

The duration of the test is:

1 h for accessories having a rated current not exceeding 32 A;

2 h for accessories having a rated current exceeding 32 A but not exceeding 125 A;

3 h for accessories having a rated current exceeding 125 A.

The temperature is determined by means of melting particles, colour-changing indicators, or thermocouples which are so chosen and positioned that they have negligible effect on the temperature being determined.

The temperature rise of terminals shall not exceed 50 K.

23. **Flexible cables and their connection**

23.1 Plugs and connectors shall be provided with a cable anchorage such that the conductors are relieved from strain, including twisting, where they are connected to the terminals or terminations, and that their covering is protected from abrasion.

Cable anchorages shall be so designed that the cable cannot touch accessible metal parts or internal metal parts, for example cable anchorage screws, if these are electrically connected to accessible metal parts, unless the accessible metal parts are connected to the internal earth terminal.

Compliance is checked by inspection.

23.2 Requirements for plugs and connector

23.2.1 *Non-rewirable plugs and connectors*

Accessories shall be provided with a flexible cable complying with IEC Publication 245-4 of one of the types specified in the following table, the nominal cross-sectional area being not less than the value shown.

TABLE IX

Preferred rated current 5) A		Type of cable	Nominal cross-section
Series I	Series II	IEC 245	mm²
16	20	53 2), 57 2), 66	2.5 1)
32	30	53 2), 66	6
63	60	66	16
125	100	66 3)	50
250	200	66 4)	150

1) Accessories having a rated operating voltage not exceeding 50 V, value increased to 4.

2) Not applicable to accessories having a rated operating voltage exceeding 415 V.

3) Only applicable for 3 P + ⏚ and 2 P + ⏚ .

4) Only applicable for 3 p + ⏚

5) For non-preferred current ratings, values are under consideration.

Flexible cables having nominal cross-sections other than those specified in Table IX may be used if the load is known.

The core connected to the earthing terminal shall be identified by the colour combination green/yellow. The nominal cross-sectional area of the earthing conductor and of the neutral conductor, if any, shall be at least equal to that of the phase conductors.

The pilot conductor, if any, shall have a nominal cross-sectional area of at least 1.5 mm².

Compliance is checked by inspection and by the test of Sub-clause 23.3.

23.2.2 *Rewirable plugs and connectors*

- it shall be clear how the relief from strain and the prevention of twisting is intended to be effected;
- cable anchorages shall present no sharp edges to the cable and shall be so designed that the anchorages or their components cannot be inadvertently lost when the accessory is being dismantled;
- makeshift methods, such as tying the cable into a knot or tying the ends with string, shall not be used;

- cable anchorages and cable inlets shall be suitable for the different types of flexible cable which may be connected.

If a cable inlet is provided with a sleeve to prevent damage to the cable, this sleeve shall be of insulating material and shall be smooth and free from burrs.

If a bell-mouthed opening is provided, the diameter at the end shall be at least 1.5 times the diameter of the cable with the largest cross-sectional area to be connected.

Helical metal springs, whether bare or covered with insulating material, are not allowed as cable sleeves.

Compliance is checked by inspection and by the test of Sub-clause 23.3.

23.3 *Plugs and connectors provided with a flexible cable are subjected to a pull test in apparatus similar to that shown in Figure 6, followed by a torque test.*

Non-rewirable accessories are tested as delivered.

Rewirable accessories are tested first with one and then with the other type of cable, complying with IEC Publication 245-4, as specified in Table X.

TABLE X

	Preferred rated current A		Type of cable	Nominal cross-section	Approximate external diameter of the cable[1]				
					Type of accessory				
	Series I	Series II	IEC 245	mm²	2 P	3 P	2 P+⏚	3 P+⏚	3 P+N+⏚
Not exceeding 50 V	16	20	66	4	13.5	14.5			
			66	10	21.3	22.8			
	32	30	66	4	13.5	14.5			
			66	10	21.3	22.8			
Over 50 V	16	20	53	1			8.1	8.8	10.0
			66	2.5			13.0	14.0	15.3
	32	30	53	2.5			11.5	12.5	14.0
			66	6.0			17.3	19.3	21.3
	63	60	66	6.0			17.3	19.3	21.3
			66	16			26.0	28.5	31.3
	125	100	66	16			26.0	28.5	31.3
			66	50			39.3	43.3	–
	250	200	66	70			44.3	48.8	–
				150			–[2]	66.3	–[2]

[1] The value for each of the approximate external diameters shown is the average value of the upper and lower limits specified in IEC Publication 245-4 for the overall diameter of the cable

[2] Values are under consideration.

Conductors of the cable of rewirable accessories are introduced into the terminals, the terminal screws being tightened just sufficiently to prevent the conductors from easily changing their position.

The cable anchorage is used in the normal way, clamping screws being tightened with a torque equal to two-thirds of that specified in Sub-clause 25.1. After reassembly of the sample, with cable glands, if any, in position, the component parts shall fit snugly and it shall not be possible to push the cable into the sample to any appreciable extent.

The sample is fixed in the test apparatus so that the axis of the cable is vertical where it enters the sample.

The cable is then subjected 100 times to a pull of the value shown in the table below. Each pull is applied without jerks and has a duration of 1 s.

Immediately afterwards, the cable is subjected for 1 min to a torque of the value shown in the following table.

TABLE XI

Preferred rated current A		Force N	Torque N · m
Series I	Series II		
16	20	80	0.35
32	30	100	0.425
63	60	120	0.8
125	100	200	1.5
250	200	300	3

During the tests, the cable shall not be damaged.

After the tests, the cable shall not have been displaced by more than 2 mm. For rewirable accessories, the ends of the conductors shall not have moved noticeably in the terminals; for non-rewirable accessories, there shall be no break in the electrical connections.

For the measurement of the longitudinal displacement, a mark is made on the cable at a distance of approximately 2 cm from the end of the sample or the cable anchorage before starting the tests. If, for non-rewirable accessories, there is no definite end to the sample, an additional mark is made on the body of the sample.

After the tests, the displacement of the mark on the cable in relation to the sample or the cable anchorage is measured.

24. Mechanical strength

24.1 Accessories shall have adequate mechanical strength.

Compliance is checked by the appropriate tests of Sub-clauses 24.2 to 24.5 as follows:

- *for socket-outlets and appliance inlets, Sub-clause 24.2;*
- *for rewirable plugs and connectors, Sub-clause 24.3* [1]*;*
- *for non-rewirable plugs and connectors, Sub-clauses 24.3* [1] *and 24.4;*
- *for glands of splashproof and watertight accessories, Sub-clause 24.5;*

- *for accessories with a degree of protection higher than IPX0, Sub-clause 24.5.*

Before starting the test of Sub-clause 24.2 or 24.3, accessories with enclosures of resilient or thermoplastic material are placed, with their bases or flexible cables, in a refrigerator at a temperature of −25 ± 2 °C for at least 16 h; they are then removed from the refrigerator and immediately subjected to the test of Sub-clause 24.2 or 24.3, as appropriate.

24.2 *Blows are applied to the samples by means of the spring-operated impact test apparatus shown in Figure 7.*

The apparatus consists of three main parts: the body, the striking element and the spring-loaded release cone.

---

[1] The test of Sub-clause 24.3 is provisional.

The body comprises the housing, the striking element guide, the release mechanism and all parts rigidly fixed thereto. The mass of this assembly is 1 250 g.

The striking element comprises the hammer head, the hammer shaft and the cocking knob. The mass of this assembly is 250 g.

The hammer head has a hemispherical face of polyamide having a Rockwell hardness of HR 100, with a radius of 10 mm; it is fixed to the hammer shaft in such a way that the distance from its tip to the plane of the front of the cone, when the striking element is on the point of release, is 28 mm.

The cone has a mass of 60 g and the cone spring is such that it exerts a force of 20 N when the release jaws are on the point of releasing the striking element.

The hammer spring is adjusted so that the product of the compression, in millimetres, and the force exerted, in newtons, equals 2 000, the compression being approximately 28 mm. With this adjustment, the impact energy is 1 ± 0.05 Nm.

The release mechanism springs are adjusted so that they exert just sufficient pressure to keep the release jaws in the engaged position.

The apparatus is cocked by pulling the cocking knob until the release jaws engage with the groove in the hammer shaft.

The blows are applied by pushing the release cone against the sample in a direction perpendicular to the surface at the point to be tested.

The pressure is slowly increased so that the cone moves back until it is in contact with the release bars, which then move to operate the release mechanism and allow the hammer to strike.

The sample is fixed as in normal use to a rigid support. Cable entries are left open and fixing screws of covers and enclosures are tightened with a torque equal to two-thirds of that specified in Table XIV.

Three blows are applied to every point that is likely to be weak.

After the test, the samples shall show no damage within the meaning of this standard; in particular, live parts shall not have become accessible and the enclosure shall show no cracks visible to the naked eye.

Watertight accessories and those with a degree of protection IPX7 and above shall withstand the relevant treatment specified in Clause 18.

Accessories with enclosures of thermoplastic material shall withstand the test of Sub-clause 19.4.

Damage to the finish, small dents which do not reduce creepage distances or clearances below the values specified in Sub-clause 26.1, and small chips which do not adversely affect the protection against electric shock or moisture are neglected.

Cracks not visible to the naked eye and surface cracks in fibre reinforced mouldings and the like are neglected.

24.3 *Rewirable accessories are fitted with the lightest type of flexible cable of the smallest cross-sectional area for the relevant rating specified in Table X.*

Non-rewirable accessories are tested as delivered.

The free end of the cable, which is about 2.25 m long, is fixed to a wall at a height of 75 cm above the floor, as shown in Figure 8.

The sample is held so that the cable is horizontal and then it is allowed to fall on to a concrete floor. This is done eight times, the cable being rotated through 45° at its fixing each time.

After the test, the samples shall show no damage within the meaning of this standard; in particular, no part shall have become detached or loosened.

Watertight accessories and those with a degree of protection IPX7 and above shall withstand the relevant treatment specified in Clause 18.

Accessories with enclosures of thermoplastic material shall withstand the test of Sub-clause 19.4.

Small chips and dents which do not adversely affect the protection against electric shock or moisture are neglected.

24.4 *Non-rewirable accessories are subjected to a flexing test in an apparatus similar to that shown in Figure 9.*

The sample is fixed to the oscillating member of the apparatus so that, when this is at the middle of its travel, the axis of the flexible cable, where it enters the sample, is vertical and passes through the axis of oscillation.

The oscillating member is so positioned that the flexible cable makes the minimum lateral movement when the oscillating member of the test apparatus is moved over its full travel.

The cable is loaded with a weight such that the force applied is as shown in the following table.

TABLE XII

Preferred rated current A		Force N
Series I	Series II	
16	20	20
32	30	25

A current equal to the rated current of the accessory is passed through the conductors, the voltage between them being the rated voltage.

The oscillating member is moved backwards and forwards through an angle of 90° (45° on either side of the vertical), the number of flexings being 20 000 and the rate of flexing 60 per minute.

After the test, the samples shall show no damage within the meaning of this standard.

A flexing is one movement, either backwards or forwards.

For accessories having a rated current exceeding 32 A, details of the test are under consideration.

24.5 *Screwed glands are fitted with a cylindrical metal rod having a diameter, in millimetres, equal to the nearest whole number below the internal diameter of the packing, in millimetres. The glands are then tightened by means of a suitable spanner, the force shown in the following table being applied to the spanner for 1 min, at a point 25 cm from the axis of the gland.*

TABLE XIII

Diameter of test rod mm	Force N	
	Metal glands	Glands of moulded material
Up to and including 20	30	20
Over 20 up to and including 30	40	30
Over 30	50[1]	40[1]

[1] These values are provisional.

After the test, the glands and the enclosures of the samples shall show no damage within the meaning of this standard.

25. Screws, current-carrying parts and connections

25.1 Connections, electrical or otherwise, shall withstand the mechanical stresses occurring in normal use.

Screws transmitting contact pressure and screws which are operated when connecting up the accessory and have a nominal diameter less than 3.5 mm shall screw into a metal nut or metal insert.

Compliance is checked by inspection and, for screws and nuts transmitting contact pressure or which are operated when connecting up the accessory, by the following test.

The screws or nuts are tightened and loosened:

- *ten times for screws in engagement with a thread of insulating material;*
- *five times for nuts and other screws.*

Screws in engagement with a thread of insulating material are completely removed and reinserted each time.

This removal and insertion of the screws or nuts shall be carried out at such a rate that the thread in the insulating material suffers no appreciable temperature rise owing to friction.

When testing terminal screws and nuts, a copper conductor having the largest cross-sectional area in Table III, rigid (solid or stranded) for socket-outlets and appliance inlets and flexible for plugs and connectors, is placed in the terminal.

The test is made by means of a suitable screwdriver or spanner. The maximum torque applied when tightening is equal to that shown in the Table XIV except that the torque is increased by 20% for screws in engagement with a thread in a hole which is obtained by plunging, if the length of the extrusion exceeds 80% of the original thickness of the metal:

TABLE XIV

Metric standard values	Nominal diameter of thread mm	Torque N · m		
		I	II	III
2.5	Up to and including 2.8	0.2	0.4	0.4
3.0	over 2.8 up to and including 3.0	0.25	0.5	0.5
–	over 3.0 up to and including 3.2	0.3	0.6	0.6
3.5	over 3.2 up to and including 3.6	0.4	0.8	0.8
4.0	over 3.6 up to and including 4.1	0.7	1.2	1.2
4.5	over 4.1 up to and including 4.7	0.8	1.8	1.8
5.0	over 4.7 up to and including 5.3	0.8	2.0	2.0
6.0	over 5.3 up to and including 6.0	1.2	2.5	3.0
8.0	over 6.0 up to and including 8.0	2.5	3.5	6.0
10.0	over 8.0 up to and including 10.0		4.0	10.0
12.0	over 10.0 up to and including 12.0			14.0
14.0	over 12.0 up to and including 15.0			19.0
16.0	over 15.0 up to and including 20.0			25.0
20.0	over 20.0 up to and including 24.0			36.0
24.0	over 24.0			50.0

Column I	*applies to screws without heads which when tightened do not protrude from the hole, and to screws which cannot be tightened by means of a screwdriver having a blade wider than the diameter of the screw.*
Column II	*applies to other screws and nuts which are tightened by means of a screwdriver.*
Column III	*applies to screws and nuts which can be tightened by means other than a screwdriver.*

Each time the clamping screw(s) or nut(s) is (are) loosened, a new conductor shall be used for a further connection.

When a screw has a hexagonal head with means for tightening with a screwdriver and the values in columns II and III are different, the test is made twice, first applying the torque specified in column III to the hexagonal head and then, on another set of samples, applying the torque specified in column II by means of a screwdriver. If the values in columns II and III are the same, only the test with the screwdriver is made.

After the test for clamping screws or nuts, the clamping unit shall not have undergone changes that adversely affect its further use.

For mantle terminals, the specified nominal diameter is that of the slotted stud.

For mantle terminals in which the nut is tightened by means other than a screwdriver and for which the nominal screw diameter is over 10 mm, the value of the torque is under consideration.

Screws or nuts which are operated when connecting up the accessory include terminal screws or nuts, assembly screws, screws for fixing covers, etc. but not connections for screwed conduits and screws for fixing socket-outlets or appliance inlets to the mounting surface.

The shape of the blade of the test screwdriver shall suit the head of the screw to be tested.

The screws and nuts shall not be tightened in jerks.

Damage to covers is neglected.

25.2 Screws in engagement with a thread of insulating material and which are operated when connecting up the accessory shall have a length of engagement of at least 3 mm plus one-third of the nominal screw diameter, or 8 mm, whichever is the shorter.

Correct introduction of the screw into the threaded hole shall be ensured.

Compliance is checked by inspection, by measurement and by manual test.

The requirement with regard to correct introduction is met if introduction of the screw in a slanting manner is prevented, for example by guiding the screw by the part to be fixed, by a recess in the threaded hole or by the use of a screw with the leading thread removed.

25.3 Electrical connections shall be so designed that the contact pressure is not transmitted through insulating material other than ceramic, pure mica or other material with characteristics no less suitable,· unless there is sufficient resiliency in the metallic parts to compensate for any shrinkage or yielding of the insulating material.

Compliance is checked by inspection.

The suitability of the material is considered with respect to its dimensional stability.

25.4 Screws and rivets which serve as electrical as well as mechanical connections, shall be locked against loosening.

Compliance is checked by inspection and by manual test.

Spring washers may provide satisfactory locking.

For rivets, a non-circular shank or an appropriate notch may be sufficient.

Sealing compound which softens on heating provides satisfactory locking only for screw connections not subject to torsion in normal use.

25.5 Current-carrying parts, other than terminals, shall be either of:

- copper;
- an alloy containing at least 50% copper;
- or other metal no less resistant ,to corrosion than copper and having mechanical properties no less suitable.

Compliance is checked by inspection and, if necessary, by chemical analysis.

The requirements for terminals are included in Clause 11.

25.6 Contacts which are subjected to a sliding action in normal use shall be of a metal resistant to corrosion.

Springs ensuring the resiliency of contact tubes shall be of metal resistant to corrosion or be adequately protected against corrosion.

Compliance is checked by inspection and, if necessary, by chemical analysis.

A test for determining the resistance to corrosion or the adequacy of the protection against corrosion is under consideration.

26. Creepage distances, clearances and distances through sealing compound

26.1 Creepage distances, clearances and distances through sealing compound shall be not less than the values in millimetres shown in Table XV.

TABLE XV

	Insulation voltage of the accessory V			
	Up to and including 50	Over 50 up to and including 415	Over 415 up to and including 500	Over 500
Creepage distance				
1. between live parts of different polarity	3	4	6	10
2. between live parts and: - accessible metal parts, - earthing contacts, fixing screws and similar devices, - external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the earthing contacts	3	4	6	10
Clearance:				
3. between live parts of different polarity	2.5	4	6	8
4. between live parts and: - accessible metal parts not listed under item 5 - earthing contacts, fixing screws and similar devices - vis external assembly screws, other than screws which are on the engagement face of plugs and are isolated from the earthing contacts	2.5	4	6	8
5. between live parts and: metal enclosures, if not lined with insulating material surface on which the base of a socket-outlet is mounted	4	6	10	10
6. between live parts and the bottom of any conductor recess in the base of a socket-outlet	4	5	10	10
Distance through sealing compound:				
7. between live parts covered with at least 2.5 mm of sealing compound and the surface on which the base of a socket-outlet is mounted	2.5	4	6	6
8. between live parts covered with at least 2 mm of sealing compound and the bottom of any conductor recess in the base of a socket-outlet	2.5	4	5	5

Compliance is checked by measurement.

For rewirable accessories, the measurements are made on the sample fitted with conductors of the largest cross-sectional area specified in Table III, and also without conductors. For non-rewirable accessories, the measurements are made on the sample as delivered.

Socket-outlets and connectors are checked when in engagement with a plug and also without a plug.

The contribution to the creepage distance of any groove less than 1 mm wide is limited to its width

Any air gap less than 1 mm wide is ignored in computing the total clearance

The surface on which the base of a socket-outlet is mounted includes any surface with which the base is in contact when the socket-outlet is installed. If the base is provided with a metal plate at the back, this plate is not regarded as the mounting surface.

26.2 Sealing compound shall not protrude above the edge of the cavity in which it is contained.

Compliance is checked by inspection.

27. Resistance to heat, fire and tracking

27.1 Accessories shall be sufficiently resistant to heat.

Compliance is checked by the tests of Sub-clauses 27.2 and 27.3.

27.2 *The samples are kept for 1 h in a heating cabinet at a temperature of 100 ± 5 °C.*

They shall not undergo any change impairing their further use, and sealing compound shall not flow to such an extent that live parts are exposed.

Marking shall still be easily legible.

A slight displacement of the sealing compound is neglected.

27.3 Parts of insulating material are subjected to a ball-pressure test by means of the apparatus shown in Figure 10.

The surface of the part to be tested is placed in the horizontal position and a steel ball of 5 mm diameter is pressed against this surface by a force of 20 N.

The test is made in a heating cabinet at a temperature of:

125 ± 5 °C for parts supporting live parts of rewirable accessories;

80 ± 3 °C for other parts.

After 1 h, the ball is removed and the diameter of the impression measured. For materials which show deformation, this diameter shall not exceed 2 mm.

For elastomeric materials a test is under consideration.

The test is not made on parts of ceramic material

27.4 External parts of insulating material and insulating parts supporting live parts of accessories shall be resistant to abnormal heat and to fire.

Compliance is checked by the glow-wire test given in IEC Publication 695-2-1 with the following specifications.

The test apparatus is shown in Figures 11a and 11b.

A piece of white pinewood board, approximately 10 mm thick and covered with a single layer of tissue paper, is positioned at a distance of 200 ± 5 mm below the place where the glow-wire is applied to the accessory.

The temperature of the tip of the glow-wire is:

650 ± 10 °C for parts of insulating material not necessary to retain current-carrying parts and parts of the earthing circuits in position, even though they are in contact with them.

850 ± 15 °C for parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuits in position.

Tests are not made on glands and sealing compounds.

Duration of the application is 30 ± 1 s.

The accessories are stored for 24 h in an atmosphere having a temperature between 15 °C and 35 °C and a relative humidity between 45% and 75% before starting the test.

The tip of the glow-wire is applied to the following places:

- *in the middle of one external part for each material, with the exception of glands and sealing compounds;*
- *in the middle of an insulating contact-carrying part for each material.*

The tip is applied to flat surfaces and not to grooves, knock-outs, narrow recesses or sharp edges and if possible not less than 9 mm from the edges of the accessories. The movement of the tip of the glow-wire into the accessory shall be mechanically limited to 7 mm.

The test is made on one specimen. In case of doubt regarding the results of the test, the test is repeated with two further specimens.

The accessories are considered to have withstood the glow-wire test if:

- *there is no visible flame and no sustained glowing, or*
- *flame or glowing of the specimen or of the surroundings extinguish within 30 s after the removal of the glow-wire, and the surrounding parts have not burned away completely. There shall be no permanent ignition of the tissue paper.*

27.5 Insulating parts supporting live parts shall be of material resistant to tracking.

For materials other than ceramic, compliance is checked by the following test.

A flat surface of the part to be tested, if possible at least 15 mm x 15 mm, is placed in the horizontal position.

Two electrodes of platinum or other sufficiently non-corrosive material, with the dimensions shown in Figure 12 are placed on the surface of the sample in the manner shown in that figure, so that the rounded edges are in contact with the sample over their whole length.

The force exerted on the surface by each electrode is about 1 N.

The electrodes are connected to a 50 Hz supply source having a voltage of 175 V, of substantially sine-wave form. The total impedance of the circuit when the electrodes are short-circuited is adjusted by means of a variable resistor, so that the current is 1.0 ± 0.1 A and cos φ is 0.9 to 1. An overcurrent relay, with a tripping time of at least 0.5 s, is included in the circuit.

The surface of the sample is wetted by allowing drops of a solution of ammonium chloride in distilled water to fall midway between the electrodes. The solution has a volume *resistivity of 400 Ω cm at 25 °C, corresponding to a concentration of about 0.1%. The drops have a volume of* 20^{+5}_{0} *mm³ and fall from a height of 30 mm to 40 mm.*

The time interval between one drop and the next is 30 ± 5 s.

No flashover or breakdown between electrodes shall occur before a total of 50 drops has fallen.

Care is taken that the electrodes are clean, correctly shaped and correctly positioned before each test is started.

In case of doubt, the test is repeated on a new set of samples.

The test is not made on accessories having rated operating voltages not exceeding 50 V.

A revision of this test is under consideration.

28. Resistance to rusting

Ferrous parts, including enclosures, shall be adequately protected against rusting.

Compliance is checked by the following test.

All grease is removed from the parts to be tested, by immersion in carbon-tetrachloride, trichloroethane or an equivalent degreasing agent for 10 min. The parts are then immersed for 10 min in a 10% solution of ammonium chloride in water at a temperature of 20 ± 5 °C.

Without drying, but after shaking off any drops, the parts are placed for 10 min in a box containing air saturated with moisture at a temperature of 20 ± 5 °C.

After the parts have been dried for 10 min in a heating cabinet at a temperature of 100 ± 5 °C, their surfaces shall show no signs of rust.

Traces of rust on sharp edges and any yellowish film removable by rubbing are ignored.

For small helical springs and the like, and for inaccessible parts exposed to abrasion, a layer of grease may provide sufficient protection against rusting. Such parts are subjected to the test only if there is doubt about the effectiveness of the grease film and the test is then made without previous removal of the grease.

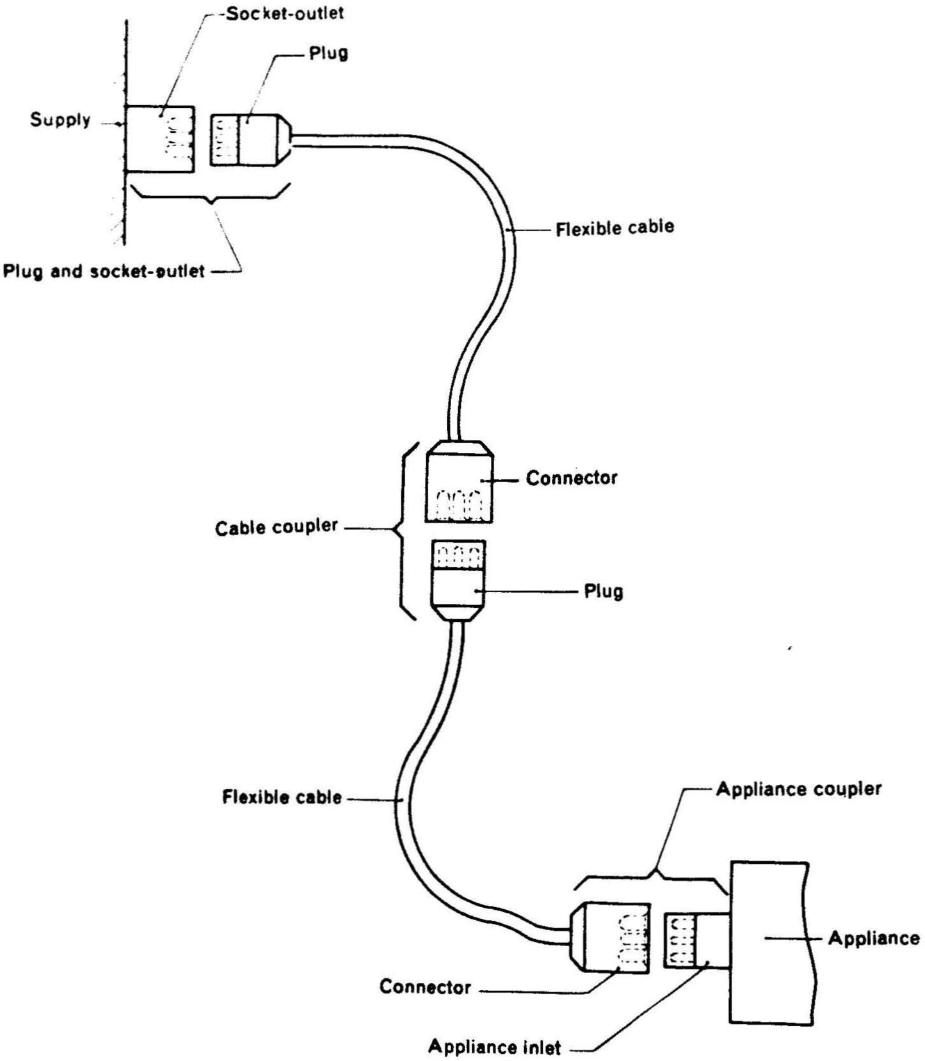
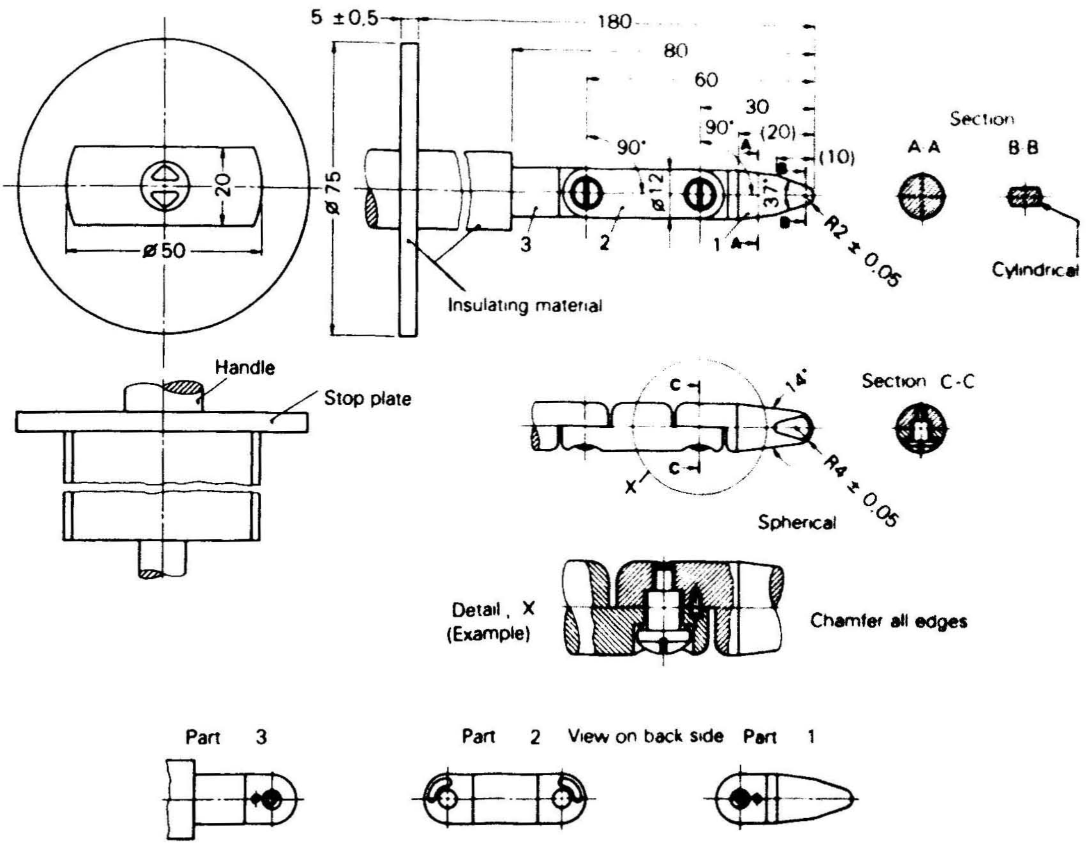


FIG. 1. — Diagram showing the use of the accessories.



Linear dimensions in millimetres

Tolerances on dimensions without specific tolerance:

on angles: $^{0}_{-10'}$

on linear dimensions:

up to 25 mm: $^{+0}_{-0.05}$

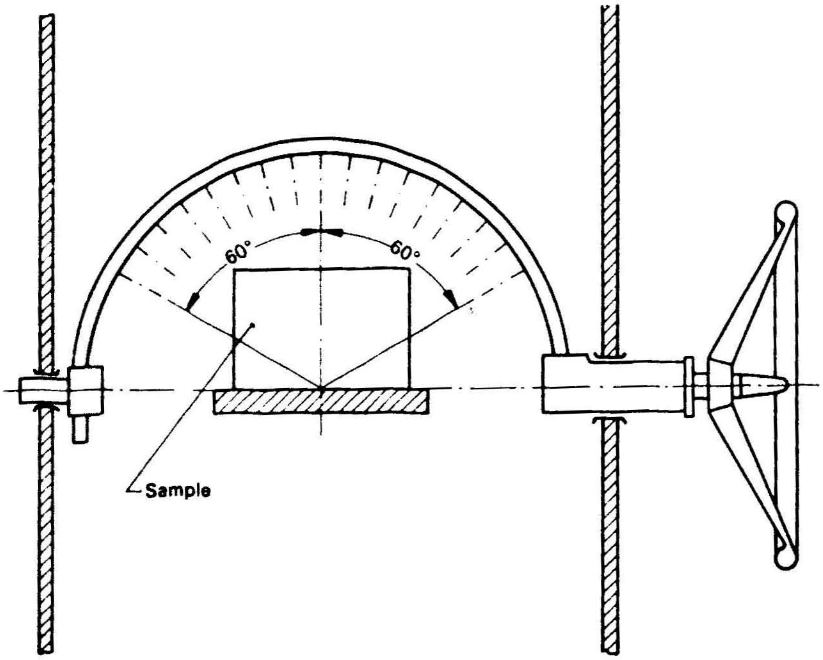
over 25 mm: ±0.2

Material of finger: e.g. heat-treated steel

Both joints of this finger may be bent through an angle of 90 $^{+10°}_{0}$, but in one and the same direction only.

Using the pin and groove solution is only one of the possible approaches in order to limit the bending angle to 90°. For this reason dimensions and tolerances of these details are not given in the drawing. The actual design must ensure a 90° bending angle with a 0 to +10° tolerance.

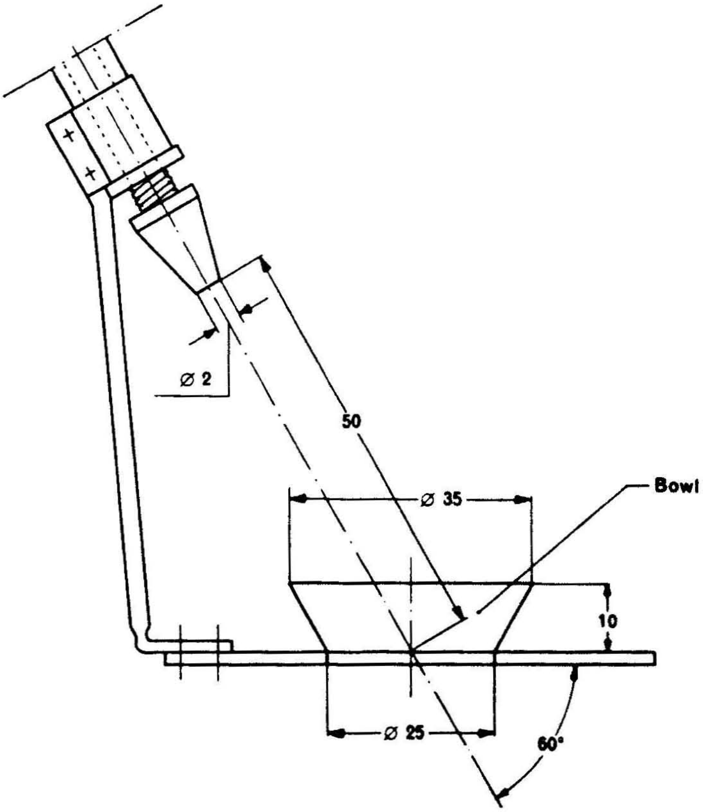
FIG. 2. — Standard test finger.



Inside diameter of tube 15 mm.

Holes 0.4 mm in diameter at 50 mm centres through wall inside bend of tube, over an arc subtending an angle of 60° on either side of the vertical.

FIG. 3. — Spray apparatus.



Dimensions in millimetres

FIG. 4. — Splash apparatus.

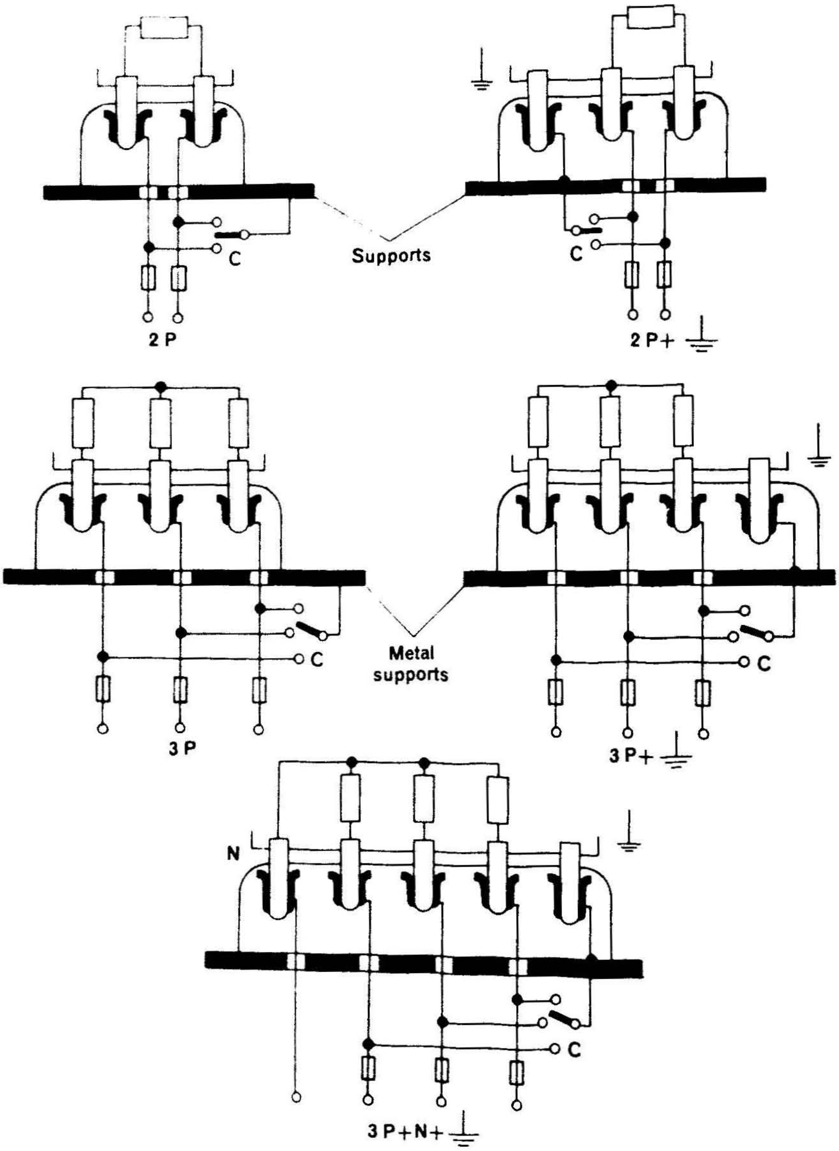
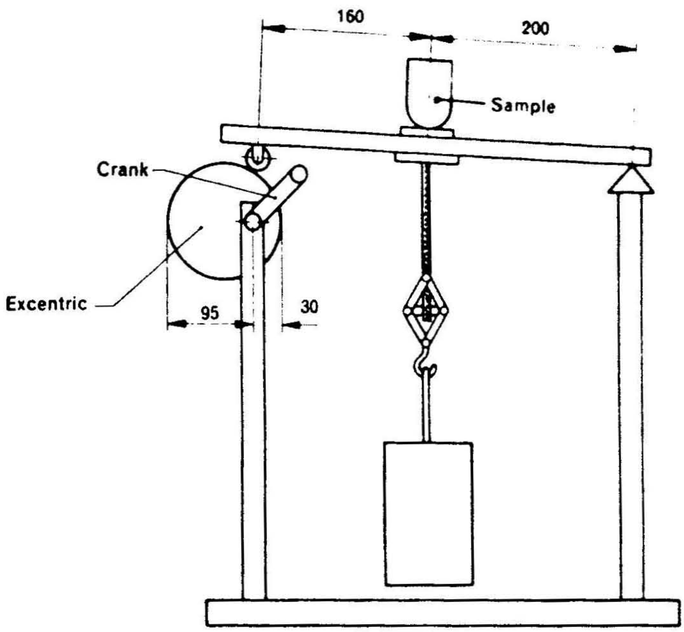


FIG. 5. — Circuit diagrams for breaking capacity and normal operation tests.



Dimensions in millimetres

FIG. 6. — Apparatus for testing the cable anchorage.

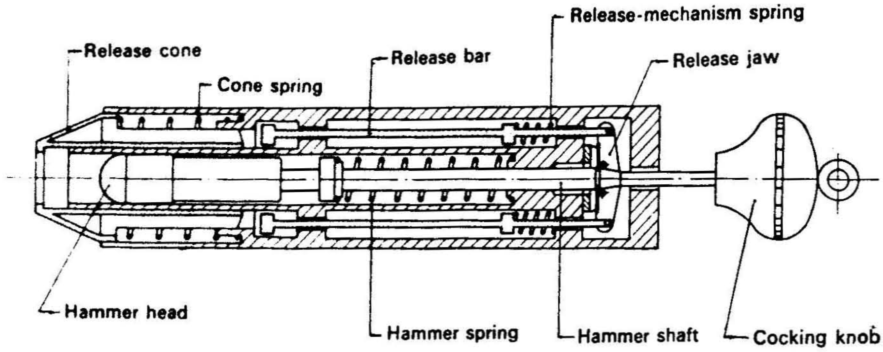
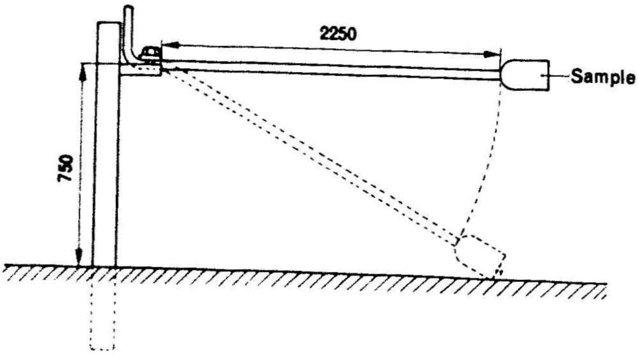
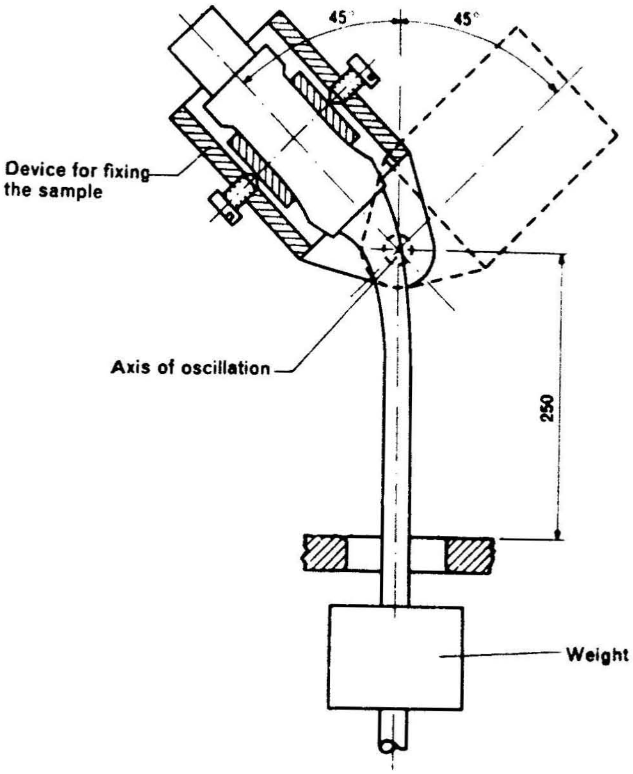


FIG. 7. — Impact-test apparatus.



Dimensions in millimetres

FIG. 8. — Arrangement for mechanical strength test for plugs and connectors.



Dimensions in millimetres

FIG. 9. — Apparatus for flexing test.

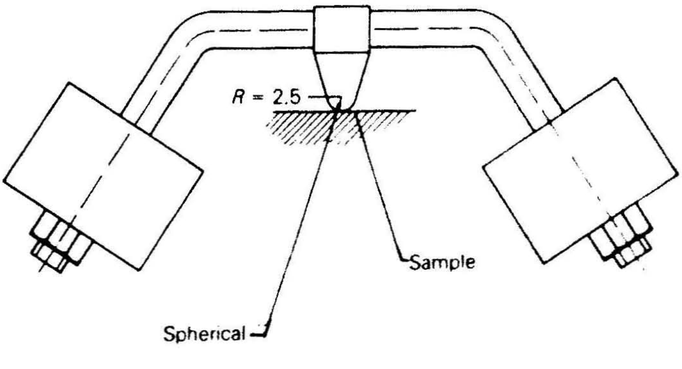
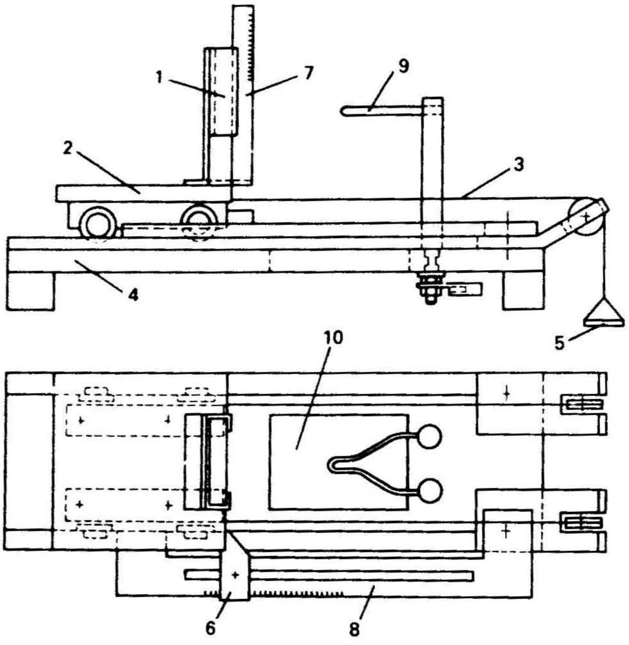
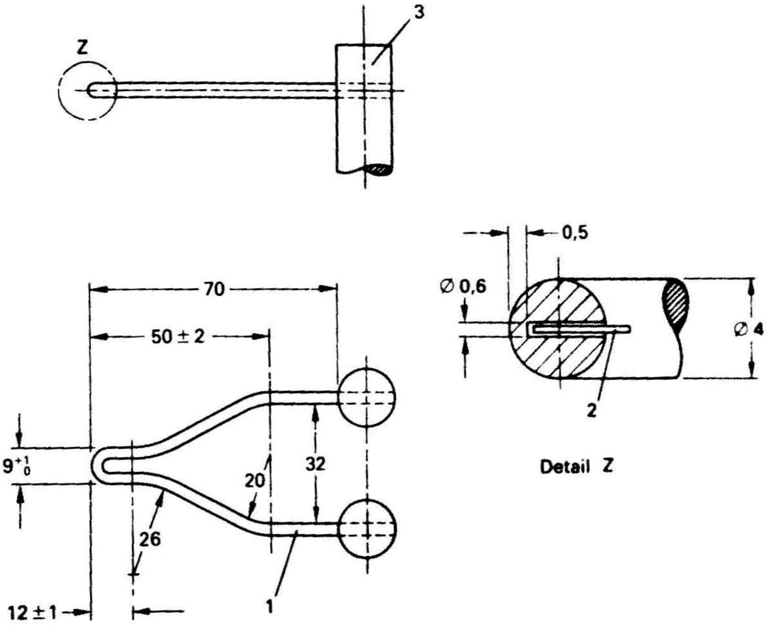


FIG. 10. — Ball-pressure apparatus.



1 positioning clamp	6 steep
2 carriage	7 scale for measure of flame
3 tensioning cord	8 scale for penetration
4 base plate	9 glow-wire
5 weight	10 break-through in base plate for particles falling from the specimen

FIG. 11a. — Test apparatus (example).

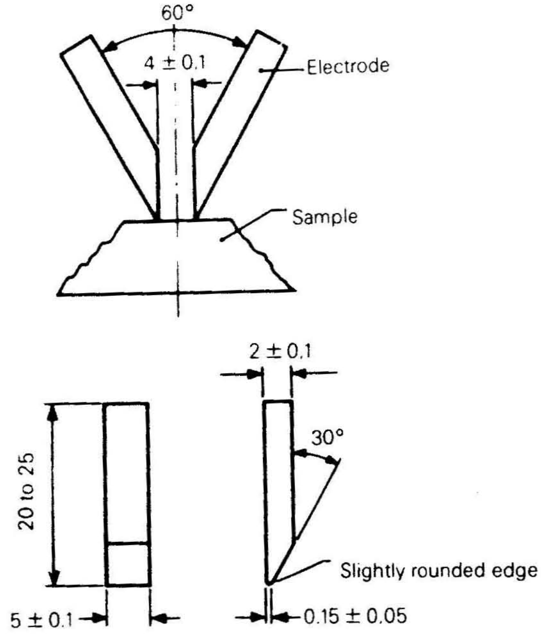


Dimensions in millimetres

1 glow-wire hard soldered at 3
2 thermocouple

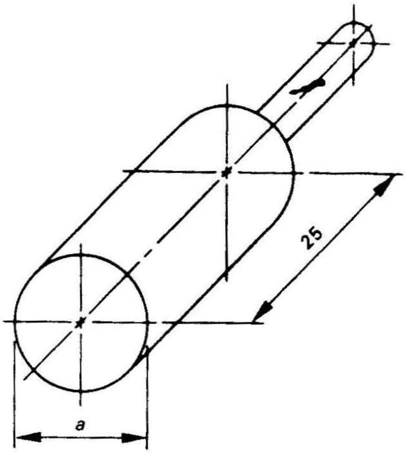
3 stud

FIG. 11b. — Glow-wire and position of the thermocouple.



Dimensions in millimetres

Fig. 12. — Arrangement and dimensions of the electrodes for the tracking test.



Conductor cross-sectional area		Gauge	
Flexible (mm²)	Rigid (solid or stranded) (mm²)	Diametre *a* (mm)	Tolerances for *a* (mm)
1,5	1,5	2,4	0 −0,05
2,5	4	2,8	0 −0,05
4	6	3,6	0 −0,06
6	10	4,3	0 −0,06
10	–	5,3	0 −0,06
16	25	6,9	0 −0,07
50	70	12,0	0 −0,08
70	–	14,0	0 −0,08
–	150	18,0	0 −0,08
150	185	20,0	0 −0,08

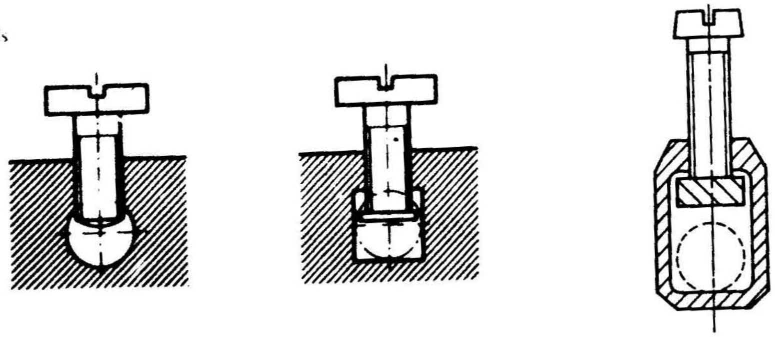
Dimensions in millimetres

Maximum cross-section of conductors and corresponding gauges.

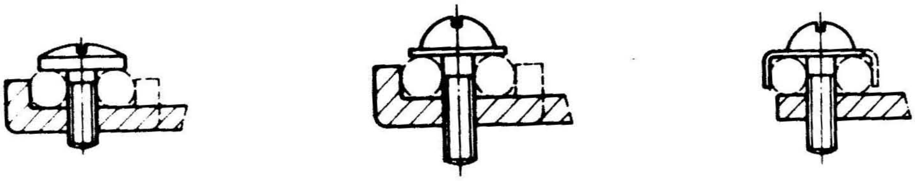
Material: steel

FIG. 13. — Gauges for testing insertability of round unprepared conductors having the maximum specified cross-section.

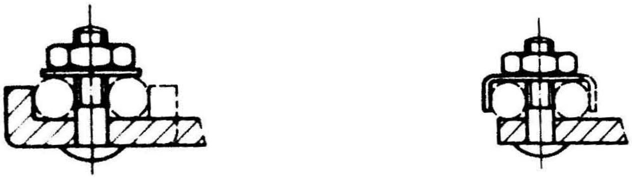
a Pillar terminals



b. c. Screw terminals.



d. Stud terminals.



e Saddle terminals

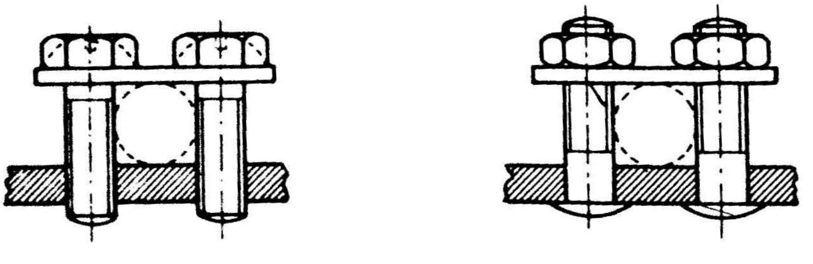
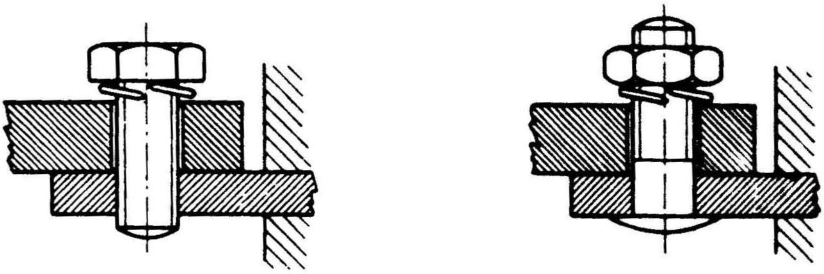


FIG. 14. — *(continued on page 55).*

f. Lug terminals.



g. Mantle terminals.

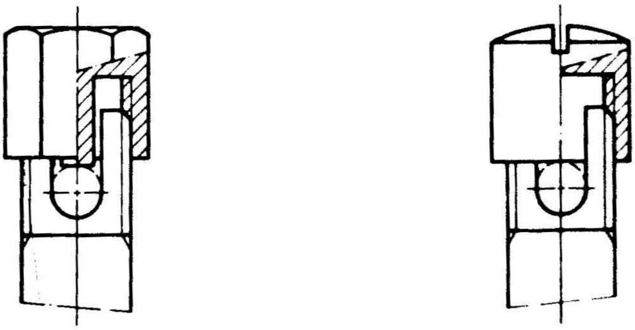


FIG. 14. — Examples of terminals.

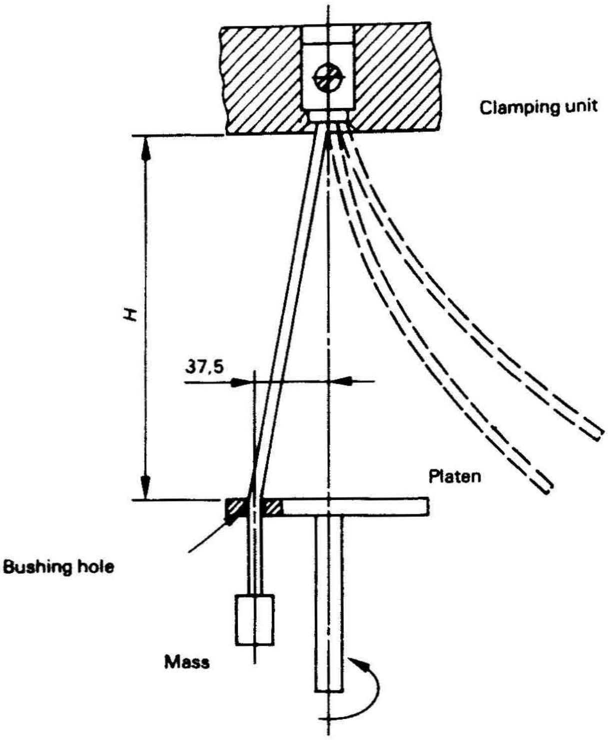


FIG. 15. — Equipment test arrangement.

APPENDIX A

Metric and AWG/MCM conductor size equivalents

Conductor size	
mm²	AWG/MCM
1,0	18
1,5	16
2,5	14
2,5	12
4,0	10
6,0	10
10	8
16	6
25	4
35	3
35	2
50	1
50	0
70	00
95	000
95	0000
120	250
150	300
185	350
185	400
240	500

Notes 1. — The nearest equivalent values are given for AWG/MCM and metric sizes.

2. — Either of the two conductors specified for a given test current range may be used.

The values recommended by IEC Sub-Committee 17B are given as a guide for use while other ratings are under consideration.

Plugs, socket-outlets and couplers for industrial purposes

Part 1: General requirements

CORRIGENDUM

Page 2

Subclause 2.1.1

Add, at the end of the first sentence:

... or incorporated in equipment.

Subclause 2.2.1

Add, at the end of the subclause:

In general, a connector has the same contact arrangement as a socket-outlet.

Subclause 2.2.2

Delete the following sentence:

In general, a connector has the same contact arrangement as a socket-outlet.

Page 5

Subclause 2.20

Delete this subclause completely.

Page 6

Subclause 6.1.2
Penultimate paragraph, altar to read:

(hinged) lids.

Page 7

Subclause 7.1, fifth dash

Delete "or identification mark", *remove the comma and add* "or" *between* "name" *and* "trade mark".

Subclause 7.2

Delete the triangle around the two drops.

Page 8

Subclause 7.3

Delete "or identification mark"
remove the comma and add "or" *between* "name" *and* "trade mark"

Add, at the end of this subclause:

The marking for rated current, nature of supply, rated operating voltage and (manufacturer's name or trade mark or the responsible vendor's name or trade mark) the name, trade mark of the manufacturer or of the responsible vendor, may be repeated on the lid, if any.

Page 9

Subclause 7.6

Delete "or identification mark", *remove the comma and add* "or" *between* "name" *and* "trade mark".

Page 24

Subclause 19.2.1

Delete the whole paragraph d)

Subclause 19.2.2

Delete the whole paragraph d).

Page 30

Table IX

In the third column, write:

IEC 245-4.

In the first column, delete from the title the footnote number 5) *and delete the corresponding note following the table.*

Page 31

Table X

In the last column, add the footnote number 2) *to two dashes.*

Page 32

Table XI

Add "Pull" *to the title of the third column.*

Page 36

Add, at the end of the page:

Screwed connections will have been partially checked by the tests of clauses 21 and 24.

Page 57

Delete Appendix A.

(Continued from second cover)

The text of IEC Standard has been approved as suitable for publication as Indian Standard without deviation.

In the adopted standard certain terminology and conventions are not identical with those used in Indian Standards, attention is specifically drawn to the following:

(a) Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.

(b) Comma (,) has been used as a decimal marker while in Indian Standard, the current practice is to use a point (.) as the decimal marker.

Only English language text in International Standard has been retained while adopting it as Indian Standard, and as such the page number given here are not the same as in IEC publication.

CROSS REFERENCES

In this Indian Standard, the following International Standards are referred to be read in their respective places :

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC Pub 227-1 (1979)	IS 694 : 1990 PVC insulated cables for working voltages up to and including 1100 V (*third revision*)	Technically equivalent
IEC Pub 228 (1978)	IS 8130 : 1984 Conductors for insulated electric cables and flexible cords (*first revision*)	Technically equivalent
IEC Pub 245-4 (1979)	IS 9968 (Part 1) : 1988 Elastomer-insulated cables: Part 1 For working voltages up to and including 1100 V (*first revision*)	Technically equivalent
IEC Pub 529 (1989)	IS 12063 : 1987 Classification of degrees of protection provided by enclosures of electrical equipment	Technically equivalent
IEC Pub 320 (1981)	Nil	—
IEC Pub 83 (1975)	Nil	—
IEC Pub 947-3 (1990) (Superseding IEC 408)	IS 13974 (Part 3) : 1993 Specification for low-voltage switchgear and control gear : Part 3 Switches, disconnectors, switch disconnectors and fuse combination units (Superseding IS 4064 (Part 1 and Part 2)	Identical
IEC Pub 695-2-1 (1980)	IS 11000 (Part 2/Sec 1) : 1984 Fire hazard testing: Part 2 Test methods, Section 1 Glow wire test and guidance	do

For the purpose of deciding whether a particular requirement of this standard is complied with final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounded off numerical values (*revised*)'. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this standard.

This standard also includes a corrigendum which is given at the end.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'.

This Indian Standard has been developed from Doc: No. ETD 14 (2813).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 323 01 31, 323 83 75, 323 94 02

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :

		Telephone
Central	Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	323 76 17 323 38 41
Eastern	1/14 C. I.T. Scheme VII M, V. I. P. Road, Maniktola CALCUTTA 700054	337 84 99, 337 85 61 337 86 26, 337 91 20
Northern	SCO 335-336, Sector 34-A, CHANDIGARH 160022	60 38 43 60 20 25
Southern	C. I. T. Campus, IV Cross Road, MADRAS 600113	235 02 16, 235 04 42 235 15 19, 235 23 15
Western	Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400093	832 92 95, 832 78 58 832 78 91, 832 78 92

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR.
COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD.
JAIPUR. KANPUR. LUCKNOW. PATNA. THIRUVANANTHAPURAM.

Printed at Simco Printing Press, Delhi